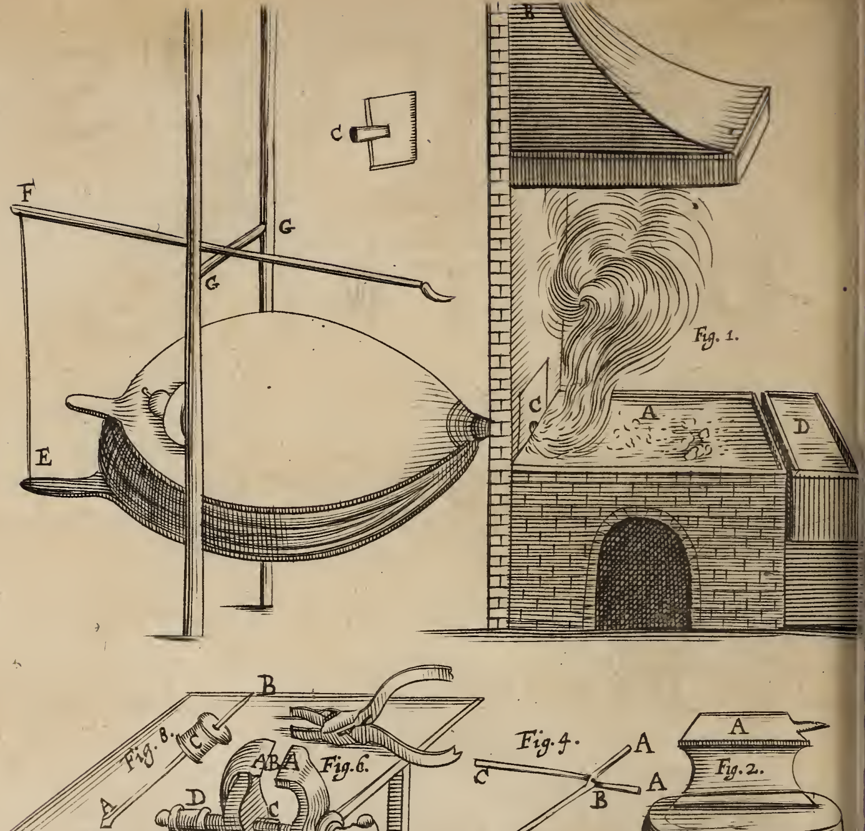
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.

# MECHANICK
# EXERCISES,
OR THE
# DOCTRINE
OF
# Handy-Works.

*Began* Jan. 1. 1677. *And intended to be continued.*

By *Joseph Moxon*, Member of the Royal Society, and *HYDROGRAPHER* to the King's Most Excellent Majesty.

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# PREFACE.

I See no more reason why the sordidness of some Workmen should be the cause of contempt upon Manual Operations, than that the excellent Invention of a Mill should be despis'd, because a blind Horse Draws in it. And though the Mechanicks be by some accounted ignoble and scandalous; yet it is very well known, that many Gentlemen in this Nation of good Rank and high Quality are conversant in Handy-Works: And other Nations exceed us in numbers of such. How pleasant and healthy this their Divertion is, their Minds and Bodyes find; and how Harmless and Honest all sober men may judge?

That Geometry, Astronomy, Perspective, Musick, Navigation, Architecture, &c. are exellent Sciences, all that know but their very names will confess: Yet to what purpose would Geometry serve, were it not to contrive Rules for Handy-Works? Or how could Astronomy be known to any perfection, but by Instruments made by Hand? What Perspective should we have to delight our Sight? What Musick to ravish our Ears? What Navigation to Guard and Enrich our Country? Or what Architecture to defend us from the inconveniences of different Weather, without Manual Operations? Or how waste and useless would many of the Productions of this and other Countries be, were it not for Manufactures.

To dive into the Original of the Mechanicks is impossible, therefore I shall not offer at it; Only I shall say, It is Rational to think that the Mechanicks began with Man, He being the only Creature that Nature has impos'd most necssity upon to use it, endow'd with greatest Reason to contrive it, and adapted with properest Members (as Instruments) to perform it.

Nor

*Nor is it easie to find by any Authority, what part of the* Mechanicks *was first Practised by* Man; *Therefore I shall wave that too ; and only consider, that if we our selves were the first Men, what Branch of the* Mechanicks *we should first* NEED, *and consequently have recourse to.*

*I have considered, and Answer, That without the Invention of* Smithing *primarily, most other* Mechanick *Inventions would be at a stand : The Instruments or Tools that are used in them being either made of Iron, or of some other matter form'd by the help of Iron. But pray take notice, that by Iron I also mean Steel, it being originally Iron.*

*Nor would I have you understand, that when I name the* Mechanicks, *I mean that rough and Barbarous sort of working which is used by the Natives of* America, *and some other such Places ; For, though they did indeed make Houses, Canoes, Earthen Pots, Bowes, Arrows, &c. without the help of Iron, because they had then none among them ; Yet since Iron is now known to them, they leave off their old way of working without it, and betake themselves to the use of it. Nor are at this day ( though now they have in part the use of Iron ) their* Machines *made by good and ready Rules of* Art ; *for they know neither of* Rule, Square, *or* Compass ; *and what they do is done by Tedious Working, and he that has the best Eye at Guessing, works best upon the* Straight, Square, *or* Circle, *&c.*

*The Lord* Bacon *in his* Natural History *reckons that* Phylosophy *would be improv'd by having the Secrets of all Trades lye open ; not only Because much* Experimental Philosophy *is Coutcht among them : but also that the* Trades *themselves might by a* Philosopher *be improved. Besides, I find that one* Trade *may borrow many Eminent Helps in* Work *of another* Trade.

*Hitherto I cannot learn that any hath undertaken this Task though I could have wisht it had been performed by an abler hand.*

*hand than mine: yet ſince it is not, I have ventured upon it: For having for many Years been converſant in* Handy-Works, *and eſpecially in thoſe* Trades *wherein the chief knowledge of all* Handy-Works *lie*, viz. Smithing, Founding, Drawing, Joynery, Turning, Engraving, Printing Books *and* Pictures. Globe *and* Map-making, Mathematical Inſtruments, &c. *I am willing to communicate to the Publique the knowledge I have attained to. But becauſe the* Whole *will be both a Work of time and great Charge, I mean to try by the Sale of ſome few* Monthly Exerciſes *what Encouragement I may have to run through All, if I live ſo long, and accordingly to Continue, or Deſiſt.*

*I thought to have givnes theſe* Exerciſes *the Title of* The Doctrine of Handy-Crafts; *But when I better conſidered the true meaning of the word* Handy-Crafts, *I found the* Doctrine *would not bear it: becauſe* Handy-Craft *ſignifies* Cunning, *or* Sleight, *or* Craft *of the Hand, which cannot be taught by Words, but is only gain'd by* Practice *and* Exerciſe: *therefore I ſhall not undertake that with the bare reading of theſe* Exerciſes *any ſhall be able to perform theſe* Handy-Works; *but I may ſafely tell you, that theſe are the* Rules *that every one that will endeavour to perform them muſt follow; and that by the true obſerving them, he may, according to his ſtock of Ingeniety and Zeal in diligence, ſooner or later inure his hand to the* Cunning *or* Craft *of working like a* Handy-Craft, *and conſequently be able to perform them in Time.*

*For the Reaſon aforeſaid I intend to begin with* Smithing, *which comprehends not only the* Black-Smiths Trade, *but takes in all* Trades *which uſe either* Forge *or* File, *from the* Anchor-Smith *to the* Watch-Maker; *they all working by the ſame* Rules, *though not with equal exactneſs, and all uſing the ſame* Tools *though of ſeveral ſizes from thoſe the common* Black-Smith *uſes, and that according to the various purpoſes they are applyed to: And in order to it, I ſhall firſt ſhew you how to ſet up a* Forge, *and what* Tools *you muſt uſe*

*in*

*in the* Black-Smiths *work*; *then the* Rules *and ſeveral* Circumſtances *of* Forging *till your Work come to the* File: *Then of the ſeveral Sorts of Iron that are commonly uſed; and what ſort is fitteſt for each Purpoſe. Afterwards of* Filing *in general, and the* Rules *to be obſerved in it, in the making of* Jacks, Hindges, Screws, Clocks, Watches, &c. *In which Examples you will find all other ſorts of* Forging *or* Filing *work whatſoever comprehended. And laſtly, as a Cloſe to* Smithing *I ſhall Exerciſe upon* Steel, *and its ſeveral Sorts, and how to order and temper it for its ſeveral Uſes; and what ſort is fitteſt for each particular purpoſe; as which is fitteſt for* Edge-Tools, *which for* Springs, *which for* Punches, &c.

*Some perhaps would have thought it more Proper to have introduced theſe* Exerciſes *with a more Curious and leſs Vulgar Art than that of* Smithing; *but I am not of their opinion; for* Smithing *is (in all its parts) as curious a* Handy-craft *as any is: Beſides, it is a great Introduction to moſt other* Handy-works, *as* Joynery, Turning, Founding, Printing, &c. *they (all with the* Smith) *working upon the* Straight, Square, *or* Circle, *though with different* Tools *upon different* Matter; *and they all having dependence upon the* Smiths Trade, *and not the* Smith *upon them. But having done with* Smithing, *I ſhall, God willing, proceed to thoſe and all other* Handy-Works *whatſoever that work by* Geometrical *Principles.*

Joſeph Moxon.

# *MECHANICK EXERCISES,*

## O R,

## The Doctrine of *Handy-Works.*

### *Of* Smithing *in general.*

#### *Definition.*

S*Mithing is an Art-Manual, by which an irregular lump (or ſeveral lumps) of Iron is wrought into an intended ſhape.*

This Definition needs no Explanation; therefore I ſhall proceed to give you an account of the Tools a Smith uſes; not but that (they being ſo common) I ſuppoſe you do already know them; but partly becauſe they may require ſome pre-caution in ſetting them up fitteſt to your uſe, and partly becauſe it behoves you to know the Names Smiths call the ſeveral parts of them by, that when I name them in Smiths Language, as I ſhall oft have occaſion to do in theſe *Exerciſes*) you may the eaſier underſtand them as you read them.

### *Of ſetting up a Smiths* Forge.

THe *Hearth*, or Fire-place of the *Fogre* marked A. (in Plate 1.) is to be built up from your floor with Brick about two foot and an half, or ſometimes two foot nine inches high, according to the purpoſe you deſign your *Forge* for: for if your *Forge* be intended for heavy work, your *Hearth* muſt lie lower than it need be for light work, for eaſineſs of management, and ſo broad as you think convenient: It may be built with hollow Arches underneath, to ſet ſeveral things out of the way. The

Back of the *Forge* is built upright to the top of the Ceiling, and inclosed over the Fire-place with a *Hovel*, which ends in a *Chimney* to carry away the Smoak, as B. In the back of the *Forge* against the Fire place, is fixed a thick Iron Plate, and a taper Pipe in it about five inches long, called a *Tewel*, or (as some call it) a *Tewel-Iron*, marked * which Pipe comes through the Back of the *Forge*, as at C. Into this taper Pipe or *Tewel* is placed the Nose or Pipe of the *Bellows*. The Office of this *Tewel* is only to preserve the Pipe of the Bellows, and the back of the *Forge* about the Fire place from burning. Right against the Back is placed at about twenty inches, or two foot distance the *Trough*, and reaches commonly through the whole breadth of the *Forge*, and is as broad and deep as you think good, as at D. The *Bellows* is placed behind the Back of the *Forge*, and hath as aforesaid its Pipe fitted into the Pipe of the *Tewel*, and hath one of its Boards fixed so that it move not upwards or downwards. At the Ear of the upper Bellows Board is fastened a *Rope*, or sometimes a *Thong* of Leather, or an Iron *Chain* or *Rod*, as E, which reaches up to the *Rocker*, and is fastened there to the farther end of the Handle, as at F. This *Handle* is fastened across a *Rock-staff*, which moves between two Cheeks upon the *Center-pins* in two Sockets, as at G. So that by drawing down this Handle, the moving Board of the *Bellows* rises, and by a considerable weight set on the top of its upper Board sinks down again, and by this Agitation performs the Office of a pair of *Bellows*.

## *Of the* Anvil.

THe shape of a Black Smiths *Anvil* I have inserted in this Figure, though it is sometimes made with a *Pike*, or *Bickern*, or *Beak-iron* at one end of it, whose use I shall shew you when I come to round hollow work. Its *Face* must be very flat and smooth, without Flaws,

and

and ſo hard that *a File will not touch it* (as Smiths ſay when a File will not cut or race it.) The upper Plain A. is called the *Face*; it is commonly ſet upon a wooden *Block* that it may ſtand very ſteady and ſolid, and about two foot high from the floor, or ſometimes higher, according to the ſtature of the perſon that is to work at it.

## *Of the* Tongs.

THere are two ſorts of *Tongs* uſed by Smiths; the one the *Straight noſed Tongs*, uſed when the work is ſhort and ſomewhat flat, and generally for all Plate Iron. The other *Crooked nos'd Tongs*, to be uſed for the forging ſmall Bars, or ſuch thicker work as will be held within the Returns of their *Chaps*. The *Chaps* are placed near the Joynt, becauſe, that conſidering the length of the *Handles*, they hold the Iron faſter than they would do were they placed farther from the Joynt, as in the Fig. 3, 4. A the the *Chaps*, B the *Joynt*, CC the *Handles*.

## *Of the* Hammer, *and the* Sledge.

THere are ſeveral ſorts of *Hammers* uſed by Black-Smiths; as firſt the *Hand-Hammer*, which is ſometimes bigger, or leſs, according to the Strength of the Work-man; but it is a *Hammer* of ſuch weight, that it may be weilded or governed with one Hand at the *Anvil*. Secondly, the *Up-hand Sledge*, uſed by under-Workmen, when the Work is not of the largeſt, yet requires help to batter or *draw it out*; they uſe it with both their Hands before them, and ſeldom lift their *Hammer* higher than their Head. Thirdly, the *About Sledge* is the biggeſt *Hammer* of all, and is alſo uſed by under-Workmen, for the battering, or *drawing out* of the largeſt Work; and then they hold the farther end of the *Handle* in both their Hands, and ſwinging the *Sledge* above their Heads, they at Arms end let fall as heavy a Blow as they can upon the Work. There is

alſo another *Hammer* uſed by them, which they call a *Rivetting Hammer:* This is the ſmalleſt *Hammer* of all, and very rarely uſed at the *Forge*, unleſs your Work prove very ſmall; but upon cold Iron it is uſed for rivetting or ſetting ſtraight, or crooking ſmall work. In Fig. 5. A the *Face*, B the *Pen*, C the *Eye*, D the *Handle*.

## *Of the* Vice.

THe *Vice* muſt be ſet up very firmly that it ſhake not, and ſtand upright with its *Chaps* parallel or range with your *Work-bench*; becauſe ſquare filing is a great piece of good Workmanſhip in a Smith; and ſhould the Vice not ſtand upright and range with the Work-bench, the *Chaps* pinching upon two ſquare ſides, would make the top ſide of your work either lean towards you or from you; and conſequently you filing (as a good Workman ought to do) upon the flat or Horizontal Plain of your work, would take off more of that Angle or Edge which riſes higher than the Plain, and leſs off that Edge that lies lower than the Plain; ſo that one Angle being higher or lower than the other, your work inſtead of being filed *Square*, would be filed *Squire-wiſe*, when you ſhall have filed all its flat ſides, and that more or leſs according to the leaning of the *Chaps* of your *Vice*. AA the *Face* hath its two ends lie in a ſtraight Line with the middle of its *Face* or *Plain*. B the *Chaps* muſt be cut with a Baſtard Cut, and very well temper'd. C the *Screw Pin* cut with a ſquare ſtrong Worm. D the *Nut* or *Screw Box* hath alſo a *Square Worm*, and is brazed into the round *Box*. E the *Spring* muſt be made of good Steel, and very well temper'd; where note, that the wider the two ends of the *Spring* ſtand aſunder, the wider it throws the *Chaps* of the *Vice* open. F the *Foot* muſt be ſtraight, and therefore will be the ſtronger to bear good heavy Blows upon the work ſcrewed in the *Chaps* of the *Vice*, that it neither bow or tremble.

Of

## *Of the* Hand-Vice.

OF the *Hand-Vice* are two ſorts,one is called the *broad Chapt Hand-Vice*, the other the *ſquare Nos'd Hand-Vice.* The Office of the *Hand-Vice*, is to hold ſmall work in that may require often turning about; it is held in the left hand, and each part of your work turned upwards ſucceſſively that you ſhall have occaſion to file with your right. The *Square Nos'd Hand-Vice* is ſeldom uſed but for filing ſmall Globulous Work, as the Heads of Pins that round off towards the Edges, *&c.* And that becauſe the *Chaps* do not ſtand ſhouldering in the way, but that the Flat of the *File* may the better come at the Edges. Their *Chaps* muſt be cut as the Vice aforeſaid, and well tempered.

## *Of the* Plyers.

PLyers are of two ſorts, *Flat Nos'd* and *Round Nos'd.* Their Office is to hold and faſten upon all ſmall work, and to fit it in its place. The *Round Nos'd Plyers* are uſed for turning or bowing Wyer or ſmall Plate into a Circular Form. The *Chaps* of the *Flat Nos'd Plyers* muſt alſo be cut and temper'd as the *Chaps* of the *Vice.* A the *Noſe*, B the *Chaps*, C the *Joynt*, D D the *Handles.*

## *Of the* Drill, *and* Drill-Bow.

DRills are uſed for the making ſuch Holes as *Punches* will not conveniently ſerve for, as a piece of work that hath already its Shape, and muſt have an hole or more made in it. Here the force of a *Punch* will ſet your work out of order and ſhape, becauſe it will both batter the Surface of the Iron, and ſtretch its Sdes out: The Shank of a Key alſo, or ſome ſuch long Hole, the *Punch* cannot ſtrike, becauſe the Shank is not forged with Subſtance ſufficient: but the *Drill*, though your

work

work be filed and polisht never batters or ſtretches it, but cuts a true round Hole juſt in the point you firſt place it. You muſt have ſeveral Sizes of *Drills*, according as your work may require. The ſhape in Fig. 8. is enough to ſhew the Faſhion of it; but it muſt be made of good Steel, and well tempered. A the *Point*, A B the *Shank*, C the *Drill-barrel:* where note, that the bigger the *Drill-barrel* is, the eaſier it runs about, but leſs ſwift.

And as you muſt be provided with ſeveral *Drills*, ſo you may ſometimes require more than one *Drill-bow*, or at leaſt ſeveral *Drill-ſtrings*; the ſtrongeſt Strings for the largeſt *Drills*, and the ſmalleſt *Strings* for the ſmalleſt *Drills*: But you muſt remember, that whether you uſe a ſmall or ſtrong String, you keep your *Drillbow* ſtraining your String pretty ſtiff, or elſe your String will not carry your Barrel briskly about. But your String and Bow muſt both be accommodated to the Size of your *Drill*; and if both or either be too ſtrong, they will break or bend your *Drill*; or if too weak, they will not carry about the Barrel as aforeſaid.

The *Drill-Plate* or *Breaſt-plate* is only a piece of flat Iron fixt upon a flat Board, which Iron hath an hole punched a little way into it, to ſet the blunt end of the Shank of the *Drill* in when you drill a hole: Workmen inſtead of it many times uſe the *Hammer*, into which they prick a hole a little way on the ſide of it, and ſo ſet the *Hammer* againſt their Breaſt.

## *Of the* Screw-plate, *and its* Taps.

THe *Screw-plate* is a Plate of Steel well temper'd, with ſeveral holes in it, each leſs than other, and in thoſe *Holes* are *Threds* groved inwards; into which *Groves* fit the reſpective *Taps* that belong to them. The *Taps* that belong to them are commonly made tapering towards the Point, as Fig. 7. ſhews. But theſe tapering *Taps* will not ſerve for ſome ſorts of work, as I ſhall ſhew in its proper place.

Theſe are the moſt Eſſential Tools uſed in the Black-Smiths Trade; but ſome accidental work may require ſome accidental Tools, which, as they may fall in, I ſhall give you an account of in convenient place.

## *Of* Forging *in general.*

I Think it needleſs to tell you how to make your Fire or blow it, becauſe they are both but Labourers work; nor how little or big it need to be; for your own Reaſon will by the Size of your work teach you that; only let me tell you the Phraſe Smiths uſe for [Make the Fire] is, *Blow up the Fire*,, or ſometimes, *Blow up the Coals.*

When it is burning with the Iron in it, you muſt with the *Slice* clap the Coals upon the outſide cloſe together to keep the heat in the body of the Fire; and as oft as you find the Fire begin to break out, clap them cloſe again, and with the *Waſher* dipt in Water, wet the outſide of the Fire to damp the outſide, as well to ſave Coals, as to ſtrike the force of the Fire into the inſide, that your work may heat the ſooner. But you ought oft to draw your work a little way out of the Fire, to ſee how it *takes its Heat*, and quickly thruſt it in again, if it be not hot enough: For each purpoſe your work is deſigned to, ought to have a proper *Heat* ſuitable to that purpoſe, as I ſhall ſhew you in the ſeveral *Heats* of Iron: For if it be too cold, it will not *feel the weight of the Hammer* (as Smiths ſay when it will not batter under the *Hammer*) and if it be too hot it will *Red-ſear*, that is, break or crack under the *Hammer*, while it is working between hot and cold.

## *Of the ſeveral* Heats *Smiths take of their Iron.*

THere are ſeveral degrees of *Heats* Smiths take of their Iron, each according to the purpoſe of their work: As firſt, a *Blood-red Heat.* Secondly, a *White Flame Heat.*

*Heat.* Thirdly, a *Sparkling* or *Welding Heat.*

The *Blood-red Heat* is uſed when Iron hath already its form and ſize, as ſometimes ſquare Bars, and Iron Plates, *&c.* have, but may want a little Hammering to ſmooth it. Uſe then the Face of your *Hand-hammer*, and with light flat Blows hammer down the irregular Riſings into the Body of your Iron, till it be ſmoth enough for the File. And note, that it behoves a good Workman to Hammer his work as true as he can; for one quarter of an hour ſpent at the *Forge*, may ſave him an hours work at the *Vice.*

The *Flame* or *White Heat* is uſed when your Iron hath not its Form or Size, but muſt be forged into both; and then you muſt take a piece of Iron thick enough, and with the *Pen* of your *Hammer*, (or ſometimes according to the ſize of your work, uſe two or three pair of hands with *Sledges* to) batter it out; or as Workmen call it to *draw it out*, till it comes to its breadth, and pretty near its ſhape; and ſo by ſeveral *Heats*, if your work require them, frame it into Form and Size; then with the Face of your *Hand-hammer* ſmooth your work from the Dents the *Pen* made, as you did with a *Blood-red Heat.*

A *Sparkling* or *Welding Heat* is only uſed when you *double up* your Iron (as Smiths call it) to make it thick enough for your purpoſe, and ſo *weld*, or work in the *doubling* into one another, and make it become one entire lump; or it is uſed when you joyn ſeveral Bars of Iron together to make them thick enough for your purpoſe, and work them into one Bar; or elſe it is uſed when you are to joyn or *weld* two pieces of Iron together end to end to make them long enough; but in this caſe you muſt be very quick at the *Forge*; for when your two ends are throughout of a good *Heat*, and that the inſide of the Iron be almoſt ready to Run as well as the outſide, you muſt very haſtily ſnatch them both out of the Fire together, and (after you have with the Edge of your *Hammer*

*Hammer* ſcraped off ſuch ſcales or dirt as may hinder their incorporating) with your utmoſt diligence clap your left hand piece upon your right hand piece, and with all ſpeed (leaſt you looſe ſome part of your good Heat) fall to Hammering them together, and work them ſoundly into one another: and this, if your Bars be large will require another, or ſometimes two or three pair of Hands beſides your own to do; but if it be not throughly *welded* at the firſt *Heat*, you muſt reiterate your *Heats* ſo oft till they be throughly *welded*; then with a *Flame Heat* (as before) ſhape it, and afterwards ſmooth it with a *Blood-red Heat*. To make your Iron come the ſooner to a *Welding Heat*, you muſt now and then with your *Hearth-ſtaff* ſtir up the Fire, and throw up thoſe Cinders the Iron may have run upon; for they will never burn well, but ſpoil the reſt of the Coals, and take a little white Sand between your Finger and your Thumb, and throw upon the heating Iron, then with your Slice quickly clap the outſide of your Fire down again; and with your *Waſher* dipt in Water, damp the outſide of the Fire to keep the Heat in.

But you muſt take ſpecial Care that your Iron *burn* not in the Fire, that is, that it do not *run* or melt; for then your Iron will be ſo brittle that it will not endure Forging without breaking, and ſo hard, that a *File* will not touch it.

Some Smiths uſe to ſtrew a little white Sand upon the *Face* of the *Anvil* alſo, when they are to hammer upon a *Welding Heat*; for they ſay it makes the Iron *weld* or incorporate the better.

If through Miſtake or ill management your Iron be too thin, or too narrow towards one of the ends; then if you have ſubſtance enough (and yet not too long) you may *up-ſet* it, that is, take a *Flame Heat*, and ſet the heated end upright upon the *Anvil*, and hammer upon the



cold

cold end till the heated end be beat or *up-ſet* into the Body of your Work. But if it be a long piece of work, and you fear its length may wrong the middle, you muſt hold it in your left hand, and lay it flat on the *Anvil*; but ſo as the heated end intended to be *up-ſet* may lie a little over the further ſide of the *Anvil*, and then with your *Hand Hammer* in your right hand beat upon the heated end of your work, minding that every ſtroak you take, you hold your work ſtiff againſt the *Face* of the *Hammer*. Afterwards ſmooth it again with a *Blood-read Heat*.

If you are to Forge a *Sholder* on one or each ſide of your work, lay the Shank of your Iron at the place where your *Sholder* muſt be on the edge of your *Anvil*(that edge which is moſt convenient to your hand) and if more *Sholders* be to be made, turn them all ſucceſſively, and hammer your Iron ſo, as that the Shank of the Iron that lies on the flat of the *Anvil* feel as well the weight of your Blows as the *Sholder* at the edge of the *Anvil*: for ſhould you lay your blows on the edge of the *Anvil* only, it would inſtead of flatting the Shank to make the *Sholder*, cut your work through.

Your work will ſometimes require to have holes punched in it at the Forge, you muſt then make a Steel *Punch* to the ſize and ſhape of the hole you are to ſtrike, and harden the point of it without tempering, becauſe the heat of the Iron will ſoften it faſt enough, and ſometimes too faſt; but then you muſt re-harden it: then taking a *Blood-heat* of your Iron, or if it be very large almoſt a *Flame Heat*; lay it upon your *Anvil*, and with your left hand place the point of the *Punch* where the hole muſt be, and with the *Hand-hammer* in your right hand punch the hole; or if your work be heavy, you may hold it in your left hand, and with your Punch fixed at the end of a *Hoop-ſtick*, or ſome ſuch Wood, hold the ſtick in your right hand, and place the point of your *Punch* on the work where the hole muſt be, and let another man ſtrike till your Punch come

come pretty near the bottom of your work; which when it does, the ſides of your work round about the hole will riſe from the Face of the *Anvil*, and your Punch will print a bunching mark upon the hole of a *Bolſter*, that is a thick Iron with a hole in it, and placing your Punch as before ſtrike it through. But you muſt note, that as oft as you ſee your Punch heat or change Colour, you take it out of the hole, and pop it into Water to re-barden it, or elſe it will batter in the hole you intend to ſtrike, and not only ſpoil it ſelf, but the Work too, by running aſide in the Work.Having punched it through on the one ſide,turn the other ſide of your work,and with your Hammer ſet it flat and ſtraight, and with a *Blood Heat* punch it through on the other ſide alſo: So ſhall that hole be fit for the *File* or ſquare bore, if the curioſity of your purpoſed work cannot allow it to paſs without filing. When your work is Forged do not quench it in water to cool it; but throw it down upon the *Floor* or *Hearth* to cool of it ſelf; for the quenching it in water will harden it: as I ſhall ſhortly ſhew you when I come to the tempering of Steel.

## *Of* Brazing *and* Soldering.

YOu may have occaſion ſometimes to *Braze* or *Solder* a piece of work; but it is uſed by Smiths only when their work is ſo thin or ſmall that it will not endure *Welding*. To do this, take ſmall pieces of Braſs, and lay them on the place that muſt be brazed, and ſtrew a little Glaſs beaten to powder on it to make it run the ſooner, and give it a *Heat* in the *Forge*, till (by ſometimes drawing it a little way out of the Fire) you ſee the Braſs run. But if your work be ſo ſmall or thin that you may fear the Iron will run as ſoon as the Braſs, and ſo you loſe your work in the Fire, then you muſt make a *Loam* of three parts Clay and one part Horſe-dung, and after they are wrought and mingled very well together in your

hands, wrap your work with the Braſs and a little beaten Glaſs upon the place to be brazed cloſe in the *Loam*, and laying it a while upon the Hearth of the *Forge* to dry, put the Lump into the Fire, and blow the *Bellows* to it, till you perceive it have a full *Heat*, that is, till the Lump look like a well burnt Coal of Fire: Then take it out of the Fire, and let it cool. Afterwards break it up and take out your work.

Thus much of Forging in general. It remains now that you know what ſorts of Iron are fitteſt for the ſeveral uſes you may have occaſion to apply them to.

## *Of ſeveral ſorts of* Iron, *and their proper uſes.*

IT is not not my purpoſe in this place to tell you how Iron is made, I ſhall defer that till I come to treat of Mettals, and their Refinings. Let it at preſent ſatisfie thoſe that know it not, that Iron is by a violent Fire melted out of hard Stones, called *Iron-Stones*; of theſe *Iron-ſtones* many Countreys have great plenty. But becauſe it waſts ſuch great quantities of Wood to draw the Iron from them, it will not in many places quit coſt to uſe them. In moſt parts of *England* we have abundance of theſe *Iron-ſtones*. But our *Engliſh* Iron is generally a courſe ſort of Iron, hard and brittle, fit for Fire-bars, and other ſuch courſe uſes: Unleſs it be about the Foreſt of *Dean*, and ſome few places more, where the Iron proves very good.

*Swediſh* Iron is of all ſorts the beſt we uſe in *England*: It is a fine tough ſort of Iron, will beſt endure the Hammer, and is ſofteſt to file; and therefore moſt coveted by Workmen to work upon.

*Spaniſh* Iron would be as good as *Swediſh* Iron, were it not ſubject to *Red-ſear*, (as Workmen phraſe it) that is to crack betwixt hot and cold. Therefore when it falls under your hands you muſt tend it more earneſtly at the Forge. But though it be a good tough ſoft Iron, yet for many

many uſes Workmen will refuſe it, becauſe it is ſo ill,and un-evenly wrought in the Bars,that it coſts them a great deal of labour to ſmooth it; but it is good for all great works that require *welding*,as the Bodies of Anvils,Sledges, large Bell-clappers, large Peſtles for Mortars, and all thick ſtrong Bars, *&c.* But it is particularly choſen by *Anchor-Smiths*,becauſe it abides the Heat better than other Iron, and when it is well wrought is tougheſt.

There is ſome Iron comes from *Holland* (though in no great quantity) but is made in *Germany*. This Iron is called *Dort Squares*, only becauſe it comes to us from thence, and is wrought into ſquare Bars three quarters of an Inch ſquare. It is a bad courſe Iron, and only fit for ſleight uſes, as Window-Bars, Brewers-Bars, Fire-Bars, *&c.*

There is another ſort of Iron uſed for making of *Wyer*, which of all other ſorts is the ſofteſt and tougheſt: But this ſort is not peculiar to any Countrey, but is indifferently made where any Iron is made, though of the worſt ſort; for it is the firſt Iron that runs from the *Stone* when it is melting,and is only preſerved for the making of *Wyer*.

By what hath been ſaid, you may ſee that the ſofteſt and tougheſt Iron is the beſt: Therefore when you chooſe Iron, chooſe ſuch as bows ofteneſt before it break,which is an Argument of Toughneſs; and ſee it break ſound within, be gray of Colour like broken Lead, and free from ſuch gliſtering Specks you ſee in broken *Antimony*, no flaws or diviſions in it: for theſe are Arguments that it is ſound and well wrought at the Mill.

## *Of* Filing *in general*.

THe ſeveral ſorts of Files that are in common uſe are the *Square*,the *Flat*,the *Three Square*,the *half Round*, the *Round*, the *Thin File*, *&c.* All theſe ſhapes you muſt have of ſeveral ſizes, and of ſeveral *Cuts*. You muſt have them

them of ſeveral ſizes, as well becauſe you may have ſeveral ſizes of work, as for that it ſometimes falls out that one piece of work may have many parts in it joyned and fitted to one another, ſome of them great, and others ſmall: And you muſt have them of ſeveral *Cuts* becauſe the *Rough Tooth'd File* cuts faſter than the *Baſtard Tooth'd File*, the *Baſtard Tooth'd File* faſter then the *Fine Tooth'd File* the *Fine Tooth'd File* faſter then the *Smooth Tooth'd File.*

The *Rough* or *Courſe Tooth'd File* (which if it be large is called a *Rubber*) is to take off the unevenneſs of your work which the *Hammer* made in the Forging: the *Baſtard Tooth'd File* is to take out of your work the deep cuts or file-ſtroaks the *Rough File* made: the *Fine Tooth'd file* is to take out the cuts or file-ſtroaks the *Baſtard file* made: and the *Smooth file* is to take out thoſe cuts or file-ſtroaks that the *fine file* made.

Thus you ſee how the *files* of ſeveral *cuts* ſucceed one another till your work is ſo ſmooth as it can be filed. You may make it yet ſmoother with *Emerick Tripoli, &c.* But of that in its proper place, becauſe it ſuits not with this Section of *Filing.*

You muſt take care when you uſe the *Rough file*, that you go very lightly over thoſe dents the *Hammer* made in your work, unleſs your work be Forged ſomewhat of the ſtrongeſt, for the dents being irregularities in your work, if you ſhould file away as much in them as you do off the eminencies or riſings, your work (whether it be ſtraight or circular) would be as irregular as it was before you filed it: And when you file upon the prominent or riſing parts of your work with your *courſe cut File*, you muſt alſo take care that you file them not more away then you need, for you may eaſily be deceived; becauſe the *courſe File* cuts deep, and makes deep ſcratches in the work; and before you can take out thoſe deep ſcratches with your finer cut Files, thoſe places where the Riſings were when your work was forged may become dents to your Ham-

mer

mer dents: Therefore file not thoſe Riſings quite ſo low as the dents the Hammer made, but only ſo low as that the ſcratches the *Rough-file* makes may lie as low or deep in your work as the Hammer dents do; for then when you come with your ſmoother Cut Files after your *rough File* the ſcrathes of your *rough File* and your Hammer ſtroaks or dents may both come out together. But to do this with greater certainty, hold your File ſo that you may keep ſo much of the length of your File as you can to rub, range or (as near range as you can) upon the length of your work; for ſo ſhall the File enter upon the ſecond Riſing on your work before it go off the firſt, and will ſlip over and not touch the dent or hollow between the two Riſings, till your Riſings are brought into a ſtraight line with your hollow dent. But of this more ſhall be ſaid when I come to the Practice of Filing upon ſeveral particular ſorts of work.

If it be a Square Bar (or ſuch like) you are to file upon, all its angles or edges muſt be left very ſharp and ſtraight. Therefore your *Vice* being well ſet up according to foregoing Directions, you muſt in your filing athwart over the *Chaps* of the *Vice* be ſure to carry both your hands you hold the *file* in truly Horizontal or flat over the work: for ſhould you let either of your hands mount, the other would dip, and the edge of that Square it dips upon would be taken off: And ſhould you let your hand move never ſo little circularly, both the edges you file upon would be taken off and the Middle of your intended flat would be left with a Riſing on it. But this Hand-craft you muſt attain to by Practice; For it is the greateſt Curioſity in filing.

If it be a round Piece or Rod of iron you are to file upon, what you were forbid upon ſquare Work, you muſt perform on the Round: For you muſt dip your Handle hand, and mount your end hand a little, and laying pritty near the end of your File to the work, file circularly

upon

upon the work, by mounting your Handle-hand by degrees, and diping your end-hand, in ſuch manner, as when the Middle of your File comes about the top of your Wok, your File may be flat upon it, and as you continue your ſtroak forwards, ſtill keep your hands moving circularly till you have finiſhed your full ſtroak, that is, a ſtroak the whole length of the File. By this manner of circular filing you keep your Piece or Rod round: But ſhould you file flat upon the top of your work, ſo many times as you ſhall remove or turn your work in the *Vice*, So many flats or ſquares you would have in your work; which is contrary to your purpoſe.

When you thruſt your file forwards lean heavy upon it, Becauſe the *Teeth* of the *File* are made to cut forwards: But when you draw your file back to recover an other thruſt, lift or bear the File lightly juſt above the work; for it cuts not coming back.

Thus much of filing in general.

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*FINIS.*

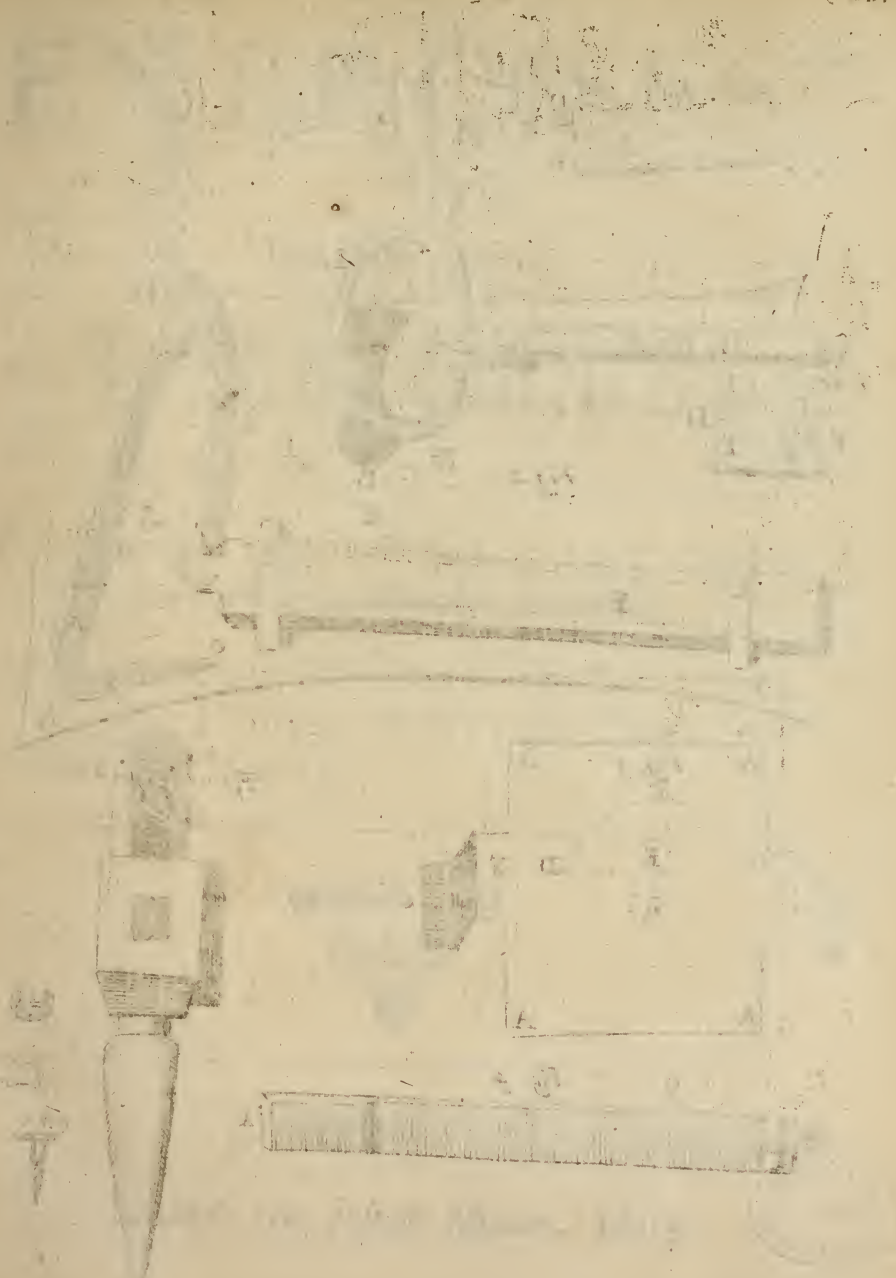
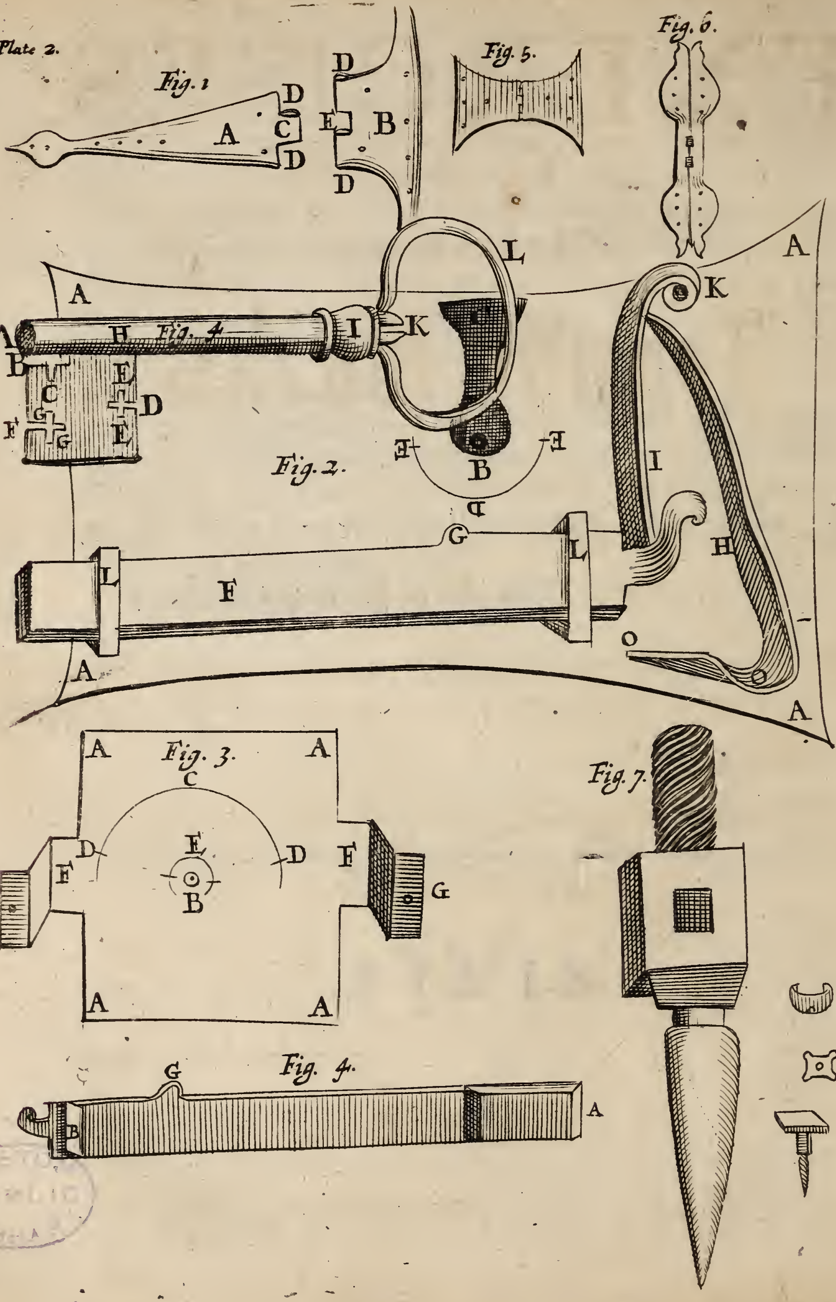


Plate 2.



# MECHANICK EXERCISES, OR, The Doctrine of Handy-works.

*From* Jan. 1. 1677. *to* Feb. 1. 1677. *And is intended to be Monthly continued.*

By *Joseph Moxon*, Member of the Royal Society, and Hydrographer to the King's Most Excellent Majesty.

LONDON.

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# *MECHANICK EXERCISES,*

## OR,

## The Doctrine of *Handy-Works.*

Applied to the making of

*Hinges, Locks, Keys, Screws and Nuts* Small and Great.

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### *Of Hinges.*

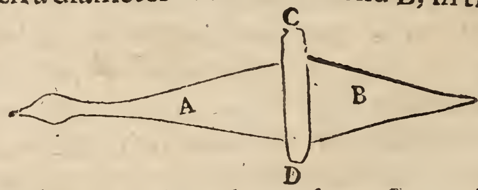
IN *Fig.* 1. A the *Tail,* B the *Croſs,* CDDDDE the *Joynt;* DDDD the *Pin-hole.* When the *Joynt* at C on the *Tail,* is pin'd into the *Joynt* at E in the *Croſs,* the whole Hinge is called a *Croſs-Garnet.*

*Hinges,* if they be ſmall (as for Cup-board doors; Boxes,&c.)are cut out of cold Plate Iron with the a *Cold-Chiſſel,* but you muſt mark the out-lines of your intended *Hinge,* as *Fig.* 1. the *Croſs-Garnet,* either with Chalk, or elſe raſe upon the Plate with the corner of the *Cold-Chiſſel,* or any other hardned Steel that will ſcratch a bright ſtroke upon the Plate: And then laying the Plate flat upon the *Anvil* if the Plate be large, or upon the b *Stake* if the Plate be ſmall, take the *Cold-Chiſſel* in your left hand, and ſet the edge of it upon that mark or raſe, and with the *Hand-Hammer* in your right hand ſtrike upon the Head of the *Cold-Chiſſel,* till you cut, or rather punch the edge of the *Cold-Chiſſel* almoſt through the Plate in that place: I ſay almoſt through, becauſe ſhould you ſtrike it quite through, the edge of the *Cold-Chiſſel* would be in danger of battering, or elſe breaking; for the *Face* of the *Anvil* is hardned Steel, and a light blow againſt its *Face* would wrong the edge of the *Cold-Chiſſel*: beſides, it ſometimes happens that the *Anvil* or *Stake* is not all over ſo hard as it ſhould be, and then

the *Cold-Chiſſel* would cut the *Face* of the *Anvil* or *Stake*, and conſequently ſpoil it: Therefore when the edge of the *Cold-Chiſſel* comes pretty near the bottom of the Plate, you muſt lay but light blows upon the *Cold-Chiſſel*; and yet you muſt ſtrike the edge of the *Cold-Chiſſel* ſo near through the bottom of the Plate, that you may break the remaining ſubſtance aſunder with your Fingers, or with a pair of *Plyers*, or ſometimes by pinching the Plate in the *Vice* with the Cut place cloſe to the ſuperficies of the *Chaps* of the *Vice*; and then with your Fingers and Thumb or your whole hand wriggle it quite aſunder. But having cut one breadth of the *Cold Chiſſel* remove the edge of it forward in the raſe and cut another breadth, and ſo move it ſucceſſively till your whole intended ſhape be cut out of the Plate.

When you cut out an *Hinge* you muſt leave on the length of the Plate A B in this Figure, Plate enough to lap over for the *Joynts*; I mean to *Turn* or *Double* about a round Pin, ſo big as you intend the Pin of your Hinge ſhall be, and alſo Plate enough to *Weld* upon the inſide of the Hinge below the *Pin-hole* of the *Joynt*, that the *Joynt* may be ſtrong.

The ſize or diameter of the *Pin-hole* ought to be about twice the thickneſs of the Plate you make the *Hinge* of, therefore lay a wyre of ſuch a diameter towards the end B, in this Figure on the *Tail-piece* a-thwart the Plate as C D, and *Double* the end of the Plate




B, over the wyre to lap over it and reach as far as it can upon the end A: then *Hammer* the Plate that is lap'd over the wyre cloſe to the wyre, to make the *Pin-hole* round: but if your Plate be thick it will require the taking of an *Heat* to make it *Hammer* the cloſer to the wyre, and conſequently make the *Pin-hole* the rounder: your work may alſo ſometimes require to be Screwed into the *Vice* with the doubled

doubled end upwards, and the bottom ſide of the wyre cloſe againſt the *Chaps* of the *Vice*, and then to *Hammer* upon the very top of the *Pin-hole*, to round it at the end alſo: when you have made the *Pin-hole* round in the inſide, take the *Pin* C D out of the *Pin-hole*, and put the *Joynt-end* of the *Hinge* into the Fire to take a *Welding-Heat*; which when it hath, ſnatch it quickly out of the Fire and *Hammer* or *Weld* the end B upon the *Tail-piece* A till they be incorporate together. But you muſt have a care that you *Hammer* not upon the Plate of the *Pin-hole*, leſt you ſtop it up or Batter it: when it is well Welded you muſt again put in the *Pin* C D, and if it will not well go into the *Pin-hole* (because you may perhaps have *Hammer'd* either upon it, or too near it, and ſo have ſomewhat cloſed it (you muſt force it in with your *Hammer*; and if it require take a *Blood-Heat* or a *Flame-Heat* of the *Joynt* end, and then force the *Pin* into the *Pin-hole* till you find the *Pin-hole* is again round within, and that the *Pin* or wyre turn evenly about within it.

Afterwards with a *Punch* of hardned Steel (as you were taught *Numb.* I. *fol.* 11, 12.) *Punch* the *Nail-holes* in the Plate: or if your Plate be very thin, you may *Punch* them with a c *Cold Punch.* After all, *ſmooth* it as well as you can with your *Hand-Hammer*: Take a *Blood-red Heat* if your work require it; if not, *Smooth* it cold; ſo ſhall the *Tail-piece* be fit for the *File.* *Double* and *Weld* the *Croſs-piece* as you did the *Tail-piece.*

Having *Forg'd* your *Hinge* fit for the *File*, you muſt proceed to make the *Joynt*, by cutting a notch in the middle of the *Pin-hole* between D D in Plate 2. on the *Croſs* as at E, and you muſt cut down the ends of the *Pin-hole* on the *Tail-piece* as at D D till the *Joynt* at C fit exactly into the notch in the *Croſs*, and that when the *Pin* is put into the *Pin-hole* D D on the *Croſs*, the *Pin-hole* in the *Tail-piece* may alſo receive the *Pin*: then by holding the *Tail-piece* in one Hand and the *Croſs* in the other, *Double* the *Tail* and *Croſs* towards one ano-

another to try if they move evenly and ſmoothly without ſhaking on the *Pin*: which if they do, the *Joynt* is made; if they do not, you muſt examine where the fault is, and taking the *Pin* out mend the fault in the *Joynt*.

Then *File* down all the irregularities the *Cold-Chiſſel* made on the edges of your Work, and (if the curioſity of your work require it) *File* alſo the outer flat of your work. But *Smiths* that make quantities of *Hinges* do *Brighten* them, (as they call it) yet they ſeldom *File* them, but *Grinde* them on a Grind-ſtone till they become *Bright*, &c.

Having finiſhed the *Joynt* put the *Pin* in again; but take care it be a little longer then the depth of the *Joynt*, becauſe you muſt batter the ends of the *Pin* over the outer edges of the *Pin-hole*, that the *Pin* may not drop out when either edge of the *Croſs* is turned upwards.

The chiefeſt curioſity in the making theſe, and (indeed) all other *Hinges* is (1) That the *Pin-hole* be exactly round and not too wide for the *Pin*. (2) That the *Joynts* are let exactly into one another, that they have no play between them, leaſt they ſhake upwards or downwards, nor yet are forced too hard into one another, leſt when they are nailed on the door the *Joynt* be in danger of breaking. (3.) That the *Croſs* and the *Tail* lye on the under-ſide exactly flat, for ſhould they warp out of flat when they are nailed on, the nails would draw the *Joynt* a-wry, and not only make it move hard and unevenly, but by oft Opening and Shutting break the *Joynt*. (4.) If your Work be intended to be curious, the true *Square-Filing* the upper-ſide as you were taught *Numb.* I. *Fol.* 14, 15, 16. is a great ornament.

*a* Smiths call all *Chiſſels* they uſe upon cold Iron, *Cold-Chiſſels*.

*b.* The *Stake* is a ſmall *Anvil*, which either ſtands upon a broad Iron foot or Baſis on the *Work-Bench*, to remove as occaſion offers; or elſe it hath a ſtrong Iron *Spike* at the bottom, which Iron *Spike* is let into ſome certain

place

place of the *Work-Bench* not to be removed. Its office is to ſet ſmall cold Work ſtraight upon, or to Cut or Punch upon with the *Cold-Chiſſel* or *Cold-Punch*.

c *Smiths* call all *Punches* they uſe upon cold Iron *Cold-Punches*.

If the *Hinge* you are to make be large, and Plate-Iron is not ſtrong enough for it, you muſt *Forge* it out of flat Bar-Iron, as you were taught *Numb.* I. *Fol.* 8. to 13.

The manner of working *Duſtails, Fig.* 5. and *Side-hinges, Fig* 6. *&c.* is (the ſhape conſidered) in all reſpects the ſame I have here ſhewed you in *Croſs-Garnets*: But in theſe (or others) you may (if your work require curioſity) inſtead of *Doubling* for the *Joynt*, *Forge* the *Round* for the *Joynt* of full Iron, and afterwards *Drill* a hole through it, for the *Pin-hole*; and by curious *Filing*, work them ſo true into one another, that both ſides of the *Hinge* ſhall ſeem but one piece: as I ſhall ſhew more at large, when I come to the making Compaſſes, and other Joynts for Mathematical-Inſtruments.

## *Of* Locks *and* Keys.

AS there are *Locks* for ſeveral purpoſes, as *Street-Door Locks*, called *Stock Locks*, *Chamber-Door Locks*, called *Spring-Locks*, *Cupboard-Locks*, *Cheſt-Locks*, *Trunk-Locks*, *Pad-Locks*, *&c* So are there ſeveral Inventions in *Locks*; I mean in the making and contriving their *Wards* or *Guards*. But theſe contrivances being almoſt innumerable, according to the various fancies of men, ſhall be referred to another time to diſcourſe: And I ſhall now ſhew you the working of a *Spring-Lock*, which when you know how to do, your Fancy may play with inventions as you beſt like.

In *Fig.* 2. A A A A the *Main plate*, B C the *Key-hole*, E D E the *Top-Hook*, E E *Croſs-wards*, F the *Bolt*, G the *Bolt-Toe*, or *Bolt-Nab*, H the *Draw-back Spring*, I the *Tumbler*, K the *Pin* of the *Tumbler* LL the *Staples*.

In *Fig.* 3. AAAA the *Cover-Plate*, B the *Pin*. DCD the *Main ward*, D D *Croſs-wards*; E the *Step-ward*; or *Dap-ward*.

In *Fig.* 4. A the *Pin-hole*, B the *Step* or *Dap-ward*, C the *Hook-ward*, D the *Middle* or *Main-Croſs-ward*, E E the *Croſs-ward*, F the *Main-ward*, G G *Croſs-ward*, H the *Shank*, I the *Pot* or *Bead*, K the *Bow-ward*, L the *Bow*, B C D E E F G G the *Bit*.

Firſt, Cut out of an Iron Plate with a *Cold-Chiſſel* the ſize and ſhape of the *Main-Plate*, as you were taught to cut the *Croſs* and *Tail-piece* of the *Croſs-Garnet*: then conſider what depth you intend the *Bit* of the *Key* ſhall have, and ſet that depth off on the *Main-Plate*, by leaving about half an Inch of Plate between the bottom of the *Key-hole*, and the lower edge of the *Main-Plate*, as at C (or more or leſs according to the ſize of the *Lock*.) Then meaſure with a pair of *Compaſſes* between the bottom of the *Bit* and the *Centre* of your *Key* (or your intended *Key*) and ſet that diſtance off from C to B near the middle between the two ends of the *Main-Plate*, and with the [a] *Prick-punch* make there a mark to ſet one *Foot* of your *Compaſſes* in, then opening your *Compaſſes* to the middle of the *Bit* of your intended *Key*, as to D, deſcribe the Arch E D E for the true place the *Top-hoop* muſt ſtand on.

Then cut out another piece of Plate as AAAA in *Fig.* 3. for a *Cover-plate*, with two pieces one on each ſide, long enough to make *Studs* of to turn downwards, and then outward again as F F, G G, that the *Cover-plate* may ſtand off the *Main-Plate* the breadth of the *Bit* of the *Key*: and at the two ends of theſe *Studs* Punch holes, as GG, to *Rivet* the *Cover-plate* into the *Main-Plate*. In the middle of this Plate make the *Centre*, as at B, then open your *Compaſſes* to three quarters the length of the *Bit*, and half the Diameter of the *Shank* of the *Key*, and placing one *Foot* in the Point B, deſcribe with the other *Foot* the Arch DCD for the true place of the *Main-ward*, then ſet your *Compaſſes* to a little more than half the Diameter of the *Shank*, and place one *Foot* (as before) in the *Centre* B, and with the other

*Foot*

*Foot* deſcribe the ſmall arch E for the true place the *Step ward* or (as ſome call it) the *Dap ward* muſt ſtand: So have you the true places of the *Wards* for an ordinary *Spring-Lock*: you may (if the depth of your *Bit* will bear it) put more *Wards* in your Plates. But you muſt note, that the more *Wards* you put in, the weaker you make your *Key*: becauſe that to every *Ward* on the Plates you muſt make a ſlit or *Ward* in the *Bit* of the *Key*; and the more *Wards* you make, the weaker the Iron of the *Bit* will be; and then if the *Bolt* ſhoot not eaſily backwards or forwards, the *Bit* may be in danger of breaking.

Having marked on your Plates the places of all your *Wards*; you muſt take thin Iron Plate, and with *Hammering* and *Filing* make them both b *Hammer-hard*, and of equal thickneſs all the way. Then *File* one edge very ſtraight by laying a *ſtraight Ruler* juſt within the edge of it, and drawing or raceing with a point of hardned Steel a bright line by the ſide of the *Ruler*: *File* away the edge of the Plate to that line, then draw (as before) another ſtraight line parallel to the firſt ſtraight line, or which is all one, parallel to the Filed edge, juſt of the breadth you intend the *Wards* ſhall be, and File it as before, only, you muſt leave two, or ſometimes three *Studs* upon this Plate, one near each end, and the other in the middle, to *Rivet* into the *Main-plate*, to keep the *Ward* fixt in its place. Therefore you muſt take care when you elect this thin piece of Plate, that it be broad enough for the *Ward* and theſe Studs too. Then laying the Plate a-thwart the *Pike* of the *Bickern*, hold your hand even with the *face* of the *Bickern*, and *Hammer* this Plate down ſomewhat by the ſide of the *Pike*, and by degrees you may (with care taken) bring it unto a Circular form, juſt of the ſize of that Circle you deſcribed on the *Main-Plate*; which when you have done, you muſt apply this *Ward* to the Circle you deſcribed on the *Main plate*, ſetting it in the poſition you intend it ſhall be fixed, and marking with a Steel Point

where the *Studs* ſtand upon that Circle, in thoſe marks *Punch* holes to *Rivet* the *Studs* to. Work ſo by all the other *Wards*.

If you have a *Pin* to the *Lock*; *Punch* a hole through the *Centre* on the *Cover-plate*, ſomewhat ſmaller than the Wyre you are to make your *Pin* of, becauſe you may then *File* one end of the *Pin* away to a *Shank*, which muſt fit the ſmaller hole on the Plate, and the whole thickneſs of the *Pin* will be a *Sholder*, which will keep the *Pin* ſteddy in the *Centre-hole* of the Plate, when the *Pin* is *Rivetted* into the Plate. But becauſe there is ſome skill to be uſed in *Rivetting*, I ſhall before I proceed any further teach you

*The manner of* Rivetting.

*Rivetting* is to batter the edges of a *Shank* over a Plate or other Iron the *Shank* is let into, ſo as the Plate or other Iron may be Clinched cloſe and fixed between the battering at the end of the *Shank* and the *Sholder*. So that

When you *Rivet* a *Pin* into a hole, your *Pin* muſt have a *Sholder* to it thicker than the hole is wide, that the *Sholder* ſlip not through the hole as well as the *Shank*: But the *Shank* of the *Pin* muſt be exactly of the ſize of the hole the *Shank* muſt be *Rivetted* into, and ſomewhat longer than the Plate is thick: *File* the end of the *Shank* flat, ſo ſhall the edges of the end the eaſilier batter over the Plate; then put your *Shank* into the hole wherein it is to be *Rivetted*, but be ſure you force the *Shank* cloſe up to the *Sholder*: then turn the top of this *Sholder* downwards (Plate and all) upon your *Stake*, but lay it ſo as that the *Sholder* lye ſolid, and the *Shank* at the ſame time ſtand directly upright, and with your left hand keep your work bearing hard upon the flat or *face* of the *Stake*. Then holding your *Hammer* in your Right Hand, hold the edge of the *face* of it dripping a-ſlope from the right hand outwards, and lay pretty light blows upon the edge of the end of the *Shank*, turning with your left hand your work round to the *face* of the *Hammer*, till you have battered the edges of the *Shank* quite round about: But this is ſeldom done with

with once turning your work about; therefore you may thus work it round again and again till you find it is pretty well *Rivetted*: then lay heavier Blows upon it, sometimes with the *Face*, sometimes with the *Pen* of the *Hammer*, till the end of the *Shank* is battered effectually over the Plate.

One main consideration in *Rivetting* is, that the *Pin* you *Rivet* in, stand upright to the Plate, or other Iron you *Rivet* it upon: for if it do not stand upright, you will be forced to set it upright after it is *Rivetted*, either in the *Vice* or with your *Plyers*, or with your *Hammer*, and that may, if your Plate be thin, bow it, or if it be thick break the *Shank* or else the *Sholder* of your *Rivet*, and so you lose your labour, and sometimes spoil your Work.

Another Consideration is, that when you *Rivet* a *Pin* to any Plate, and you fear it may afterwards twist about by some force that may be offered it, you must, to provide against this danger, *File* the *Shank* you intend to *Rivet* either Square or Triangular, and make the hole in the Plate you *Rivet* it into of the same size and form, and then *Rivet* in the *Shank* as before. There are two ways to make your Hole Square or Triangular, one is by *Filing* it into these forms when it is first Punched round; the other by making a *Punch* of Steel of the size and shape of the *Shank* you are to *Rivet*, and *Punching* that *Punch* into the Plate, make the same form.

Now to return where I left off. The *Pins* or *Shanks* of these *Wards* must be made of a long square form, because, (the Plates of these *Wards* being thin) should you make them no broader than the Plate is thick, the *Studs* or *Shanks* would be too weak to hold the *Wards*, therefore you must make the *Rivetting Shank* three or four times, or sometimes more, as broad as the Plate is thick, and then *Rivet* them in, as you were taught just now.

Then place the *Cover-plate* upon the *Main-plate*, so as the *Centre* of the *Cover-plate* may stand directly over and against the *Centre* of the *Main-plate*, and make marks through the

Hole G G, of the *Studs* of the *Cover-plate* upon the *Main-plate*, and on thoſe marks Punch holes, and fit two *Pins* into them to faſten the *Cover-plate* on to the *Main-plate*,but you muſt not yet *Rivet* them down till the *Key-hole* be made, becauſe this *Cover-plate* would then ſtop the progreſs of the *File* through the *Main plate* when you *File* the *Key-hole*. When you have placed the *Cover-plate* upon the *Main-plate*, and fitted it on with *Pins*, ſo, as you may take it off and put it on again as your Work may require, you muſt *Punch* the *Key-hole*, or rather *Drill* two holes cloſe by one another, if the *Key hole* falls near the *Wards*, becauſe *Punching* may be apt to ſet the *Wards* out of form, and with ſmall *Files*, File the two holes into one another to make the hole big enough to come at with bigger *Files*, and then File your *Key-hole* to your intended ſize and ſhape.

The *Key-hole* being finiſhed, *Forge* your *Key*, as you were taught, *Numb.* I. *fol.* 8. and if your *Key* is to have a *Pin-hole*, *Drill* the hole in the middle of the end of the *Shank*, then *File* the *Wards* or ſlits in the *Bit* with thin *Files*; yet ſometimes *Smiths Punch* or *Cut* them with a *Cold-Chiſſel*, at the ſame diſtances from the middle of the *Pin-hole* in the end of the *Shank* (which is the ſame *Centre* which was made before in the *Main-plate* on the *Cover-plate*) which you placed the *Wards* at from the *Centre* of the *Main* and *Cover-plate*. But before you *File* theſe *Wards* too deep into the *Bit* of the *Key*, make tryals, by putting the *Bit* into the *Key-hole*, whether the *Wards* in the *Bit* will agree with the *Wards* on the Plates, which if they do, you may boldly Cut them to the depth of the *Wards* on the Plates; if not, you muſt alter your courſe till they do: but you muſt take great care in Cutting the *Wards* down ſtraight and ſquare to the ſides of the *Bit*; for if they be not Cut down ſtraight, the *Wards* on the Plates will not fall in with the *Wards* in the *Bit* of the *Key*; and if they be not ſquare to the ſides of the *Bit*, the *Bit* will not only be weaker than it need be; but

but it will ſhew unhandſomely, and like a Botch to the Eye.

The *Croſs* and *Hook-wards* is made, or at leaſt entred at the *Forge*, when the Iron hath a *Blood* or almoſt a *Flame-heat*, yet ſometimes *Smiths* do it on Cold Iron, with a thin *Chiſſel* as you were taught *Numb.* I. *fol.* 11, 12. But you muſt take care that your *Chiſſel* be neither too thick or too broad, for this Punching of *Wards* is only to give the thin *Files* entrance to work; which entrance when you have, you may eaſily *File* your *Croſs* or *Hook-wards* wider or deeper as your Work may require: But if your *Chiſſel* be too broad or too thick, it will make the *Wards* in the *Bit* too long or too wide, and then (as I ſaid before,) the *Bit* of your *Key* will prove weaker than it needs to be.

Having made the *Wards* on the Plate and in the *Bit* of the *Key*, you muſt *Forge* the *Bolt* of a conſiderable ſubſtance, thick and ſquare at the end that ſhoots into the *Staple* in the frame of the Door, that it may be ſtrong enough to guard the whole Door; But the reſt of the *Bolt* that lies between the two *Staples* on the *Main-plate* may be made very thin inwards, that is, the ſide that lies towards the *Main-plate*, which becauſe it cannot be ſeen when the *Bolt* is fixed upon the Plate, I have made a Figure of it, and turned the inſide to view, as in *Fig.* 4. where you may ſee that the end A hath a conſiderable ſubſtance of Iron to guard the whole Door as aforeſaid, and B is a ſquare *Stud* which doth as well keep the outſide flat of the *Bolt* on the Range, as ſerve for a *Stud* for the *Spring* H in *Fig.* 2. to preſs hard againſt, and ſhoot the *Bolt* forwards: This *Bolt* muſt be wrought ſtraight on all its ſides, except the Topſide, which muſt be wrought ſtraight only as far as the *Sholder* G called the *Toe* or *Nab* of the *Bolt*, which riſes as you ſee in the Figure conſiderably high above the ſtraight on the Top of the *Bolt*: The office of this *Nab* is to receive the bottom of the *Bit* of the *Key* when in turning it about it ſhoots the *Bolt* backward or forwards.

Having *Forged* and *Filed* the *Bolt*, you muſt fit the hollow

ſide

ſide of it towards the *Main plate*, at that diſtance from the *Key-hole*, that when the *Key* is put into the *Key-hole*, and turned towards the *Bolt*, the bottom of the *Bit* may fall almoſt to the bottom of the *Nab*, and ſhoot the *Bolt* back ſo much as it needs enter the *Staple* in the *Door-Frame*. And having found this true place for the *Bolt*, you muſt with ſquare *Staples*, juſt fit to contain the *Bolt* with an eaſie play, faſten theſe *Staples* by *Rivetting* them with the *Bolt* within them, one near the *Bolt* end, the other near the *Nab* end, as at L L to the *Main-plate*.

Then *Punch* a pretty wide hole in the *Main-plate*, as at K, to receive a ſtrong *Pin* and *File* a *Sholder* to the *Shank* of the *Pin* that goes into the Plate: This *Pin* is called the *Pin of the Tumbler*: The *Tumbler* is marked I, which is a long piece of Iron with a round hole at the Top to fit the *Pin* of the *Tumbler* into, that it may move upon it as on a *Joynt*, and it hath an *Hook* returning at the lower end of it, to fall into the breech of the *Bolt*, and by the *Spring* H forces the *Bolt* forwards when it is ſhot back with the *Key*. This *Spring* is made of Steel, and afterwards temper'd (as I ſhall ſhew you in proper place:) It is fixed at the bottom of the *Main-plate*, by two ſmall *Shanks* proceeding from that edge of the *Spring* that lies againſt the *Main-plate* as at O O: Theſe *Shanks* are to be *Rivetted* (as you were taught even now) on the other ſide of the *Main-plate*.

All things being thus fitted, *Punch* an hole on each corner of the *Main-plate* for *Nails* to enter, that muſt Nail the *Lock* to the Door. Or if you intend to *Screw* your *Lock* on the Door, you muſt make wide holes, big enough to receive the *Shank* of the *Screw*. Laſt of all *Rivet* down your *Cover-plate* to the *Main-plate*, and *File* your *Key*, and *Poliſh* it too, if you will; ſo ſhall the *Lock* and *Key* be finiſhed.

a A *Prick punch* is a piece of temper'd Steel with a round point at one end, to prick a round mark in Cold Iron.

b *Hammer-hard* is when you harden Iron or Steel with much Hammering on it.

*The*

## *The making of* Screws *and* Nuts.

THe *Shank* of the *Screw* for Doors and many other purposes must be *Forged* square near the *Head*, because it must be let into a square hole that it may not twist about when the *Nut* is turned about hard upon the *Screw-Pin*. Therefore take a square Bar or Rod of Iron as near the size of the *Head* of the *Screw-Pin* as you can, and taking a *Flame-Heat* of it, lay so much of this Bar as you intend for the length of the *Shank*, with one square side flat, upon the hither side of the *Anvil*, and *Hammer* it down to your intended thickness: But have a care you do not strike your Iron on this side the edge of the *Anvil*, lest you cut the Iron, as I told you *Numb.* I. *fol.* 11. Thus at once you will have two sides of your *Shank Forged*; the under-side made by the *Anvil*, and the upper side beaten flat with the *Hammer*: The *Head* will be in the Main Rod of Iron: then if your Iron grows Cold, give it another *Heat*, and lay one of the un-wrought sides upon the hither-side of the *Anvil* just to the *Head*, and *Hammer* that down as before, so shall the two other square sides be made: then *Hammer* down the Corners of so much of this *Shank* as you intend for the *Screw-Pin*, and round it as near as you can with the *Hammer*; set then the *Chissel* to the thickness you intend the *Head* shall have, and strike it about half through, then turn the sides successively, and cut each side also half through till it be quite cut off. If the *Sholder* be not square enough, hold it in your *Square-Nos'd Tongs*, and take another *Heat*, and with speed ( lest your Work cool ( Screw the *Shank* into the *Vice*, so as the *Sholder* may fall flat upon the *Chaps* of the *Vice*; then *Hammer* upon the *Head*, and square the *Sholder* on two sides, do the like for squaring the other two sides. This was in part taught you before, in *Numb.* I. *fol.* 11. but because the cutting this Iron Rod or Bar, just above the *Sholder* makes the *Head*, and

for that I did not mention it there, I thought fit (ſince the purpoſe required it) to do it here: The *Forging* of the *Nuts* are taught before, *Numb.* I. *Fol.* 11, 12.

Having *Forged* and *Filed* your *Shank* ſquare, and the *Head* either ſquare or round, as you intend it ſhall be, *File* alſo the *Screw-Pin*, from the riſings and dents left at the *Forge*; and *File* it a little Tapering towards the end, that it may enter the *Screw-Plate*: The Rule how much it muſt be Tapering is this, conſider how deep the Inner *Grooves* of the *Screw-Plate* lye in the outer *Threds*, and *File* the end of the *Screw-Pin* ſo much ſmaller than the reſt of the *Screw-Pin*, for the outer *Threds* of the *Screw-Plate* muſt make the *Grooves* on the *Screw-Pin*, and the *Grooves* in the *Screw-Plate* will make the *Threds* on the *Screw-Pin*. Having fitted your ſelf with a *Hole* in your *Screw-Plate* (that is ſuch a *Hole* whoſe Diameter of the hollow *Grooves* ſhall be equal to the Diameter of the *Screw-Pin*, but not ſuch an *Hole* whoſe Diameter of the outer *Threds* ſhall be equal to the Diameter of the *Screw-Pin*, for then the *Screw-Plate* will indeed turn about the *Screw-Pin*, but not cut any *Grooves* or *Threds* in it) *Screw* the *Shank* with the *Head* downwards in the *Vice*, ſo as that the *Screw-Pin* may ſtand directly upright, and take the *Handle* of the *Screw-Plate* in your Right-hand, and lay that *Hole* flat upon the *Screw-Pin*, and preſs it pretty hard down over it, and turn the *Screw-Plate* evenly about with its *Handle* towards you, from the Right towards the Left hand, ſo ſhall the outer *Threds* of the *Screw-Plate* cut *Grooves* into the *Screw-Pin*, and the ſubſtance of the Iron on the *Screw Pin* will fill up the *Grooves* of the *Screw-Plate*, and be a *Thred* upon the *Screw-Pin*. But take this for Caution, that as I told you you muſt not make your *Screw-Pin* too ſmall, becauſe the *Screw-Plate* will not then cut it, ſo if you make it too big (if it do enter the *Screw-Plate* where it is Taper) it will endanger the breaking it, or, if it do not break it, yet the *Screw-Plate* will after it gets a little below the Tapering,

go

go no further, but work and wear off the *Thred* again it made about the tapering.

To fit the *Pin* therefore to a true ſize, I in my Practiſe uſe to try into what *Hole* of the *Screw Plate*, the *Tap* or place of the *Tap*,(if it be a tapering *Tap*,)I make the *Nut* with will juſt ſlide through ; (*Threds* and all ;) ( which generally in moſt *Screw-Plates* is the *Hole* next above that to be uſed) for then turning my *Pin* about in that *Hole*, if the *Pin* be irregularly *Filed*, or but a little too big on any part of it, the *Threds* of that *Hole* will cut ſmall marks upon the *Pin*; on the Irregular places, or where it is too big: ſo that afterwards *Filing* thoſe marks juſt off, I do at once *File* my *Pin* truly round, and ſmall enough to fit the *Hole* I make my *Screw-Pin* with.

As the *Hole* of the *Screw-Plate* muſt be fitted to the *Screw-Pin*, ſo muſt the *Screw-Tap* that makes the *Screw* in the *Nut*, be fitted to the round *Hole* of the *Nut* ; but that *Tap* muſt be of the ſame ſize of your *Screw-Pin* too, which you may try by the ſame *Hole* of the *Screw Plate* you made the *Screw-Pin* with. *Screw* the *Nut* in the *Vice* directly flat, that the *Hole* may ſtand upright, and put the *Screw Tap* upright into the *Hole* : then if your *Screw-Tap* have an *Handle*, turn it by the *Handle* hard round in the *Hole*, ſo will the *Screw-Tap* work it ſelf into the *Hole*, and make *Grooves* in it to fit the *Threds* of the *Screw-Pin*. But if the *Screw-Tap* have no *Handle*, then it hath its upper end Filed to a long ſquare , to fit into an hollow ſquare, made near the *Handle* of the *Screw-Plate* : Put that long ſquare hole over the long ſquare on the top of the *Tap*, and then by turning about the *Screw-Plate*, you will alſo turn about the *Tap* in the *Hole*, and make *Grooves* and *Threds* in the *Nut*.

But though ſmall *Screws* are made with *Screw-Plates* , yet great *Screws*, ſuch as are for *Vices*, *Hot-Preſſes*, *Printing-Preſſes*, &c. are not made with *Screw-Plates*, but muſt be cut out of the main Iron, with heavy blows upon a *Cold-Chiſſel*: The manner of making them is as follows.

F 2 *The*

## *The Rules and manner of* Cutting Worms *upon great* Screws.

THe *Threds* of *Screws* when they are bigger than can be made in *Screw plates* are called *Worms*. They consist in length, breadth and depth: the length of a *Worm* begins at one end of the *Spindle* and ends at the other: the breadth of the *Worm* is contained between any two *Grooves* on the *Spindle*, *viz.* the upper and under *Groove* of the *Worm* in every part of the *Spindle*: The depth of the *Worm* is cut into the Diameter of the *Spindle*, *viz.* the depth between the outside of the *Worm* and the botom of the *Groove*.

The depth ought to be about part $\frac{1}{7}$ of the Diameter on each side the *Spindle*.

You ought to make the *Groove* wider than the *Worm* is broad, because the *Worm* being cut out of the same intire piece with the *Spindle*, will be as strong as the *Worm* in the *Nut*, though the *Worm* on the *Spindle* be smaller; for you cannot come at the *Worm* in the *Nut* to cut it with *Files* as you may the *Spindle*, and therefore you must either *Turn* up a Rod of Iron to twist round about the *Grooves* on the *Spindle*, and then take it off and *Braze* it into the *Nut*, or else you must *Cast* a *Nut* of *Brass* upon the *Spindle*, which will neither way be so strong as the *Worm* cut out of the whole Iron, by so much as *Brass* is a weaker Mettal than Iron; and therefore it is that you ought to allow the *Worm* in the *Nut* a greater breadth than the *Worm* on the *Spindle*, that the strength of both may as near as you can be equalized: for both being put to equal force, ought to have equal strength. The *Worm* may very well be $\frac{1}{7}$ part smaller than the *Groove* is wide; as aforesaid.

Having considered what breadth the *Worm* on the *Spindle* shall have, take a small thin Plate of Brass or Iron, and *File* a square notch at the end of it, just so wide and so deep as your *Worm* is to be broad and deep, and *File* the sides of the

the Plate that this notch ſtands between juſt to the width of the *Groove*. This Plate muſt be a *Gage* to *File* your *Worm* and *Groove* to equal breadth by: then draw a ſtraight and upright line the whole length of the *Spindle*; divide from this line the Circumference of the whole *Spindle* into eight equal parts, and through thoſe diviſions draw ſeven lines more parallel to the firſt line; Then open your *Compaſſes* juſt to the breadth of one *Worm* and one *Groove*; and ſet off that diſtance ſo oft as you can, from the one end of the *Spindle* to the other (but I ſhould firſt have told you that the end of your *Spindle* muſt be truly ſquare to the outſide) and with a *Prick-Punch* make a mark to every ſetting off on that line: Do the like to all the other ſtraight upright lines. Note, that you may chooſe any of theſe eight upright lines for the firſt, and make the next towards your Left hand, the ſecond (but then the firſt muſt ſtand towards you) and the next that, the third, and ſo on. And the top mark of every one of theſe upright ſtraight lines ſhall be called the firſt mark, the next under that the ſecond mark, the third the third mark, and ſo downwards in order and number.

Having marked one of theſe eight lines at the top of the *Spindle* to begin the winding of the *Worm* at, with a black Lead Pencil, draw a line from that mark to the ſecond mark on the next upright line towards the Left hand, from thence continue drawing on with your Pencil to the third mark; on the third upright line, draw on ſtill to the fourth mark on the fourth upright line, and ſo onwards till you have drawn over the eight ſtraight lines, which when you have done, you muſt ſtill continue on drawing downwards to each lower mark on each ſucceſſive upright line, till you have drawn your *Worm* from end to end: Then examine as well as you can by your Eye, whether the *Worm* you have carried on from mark to mark with the Black-lead Pencil do not break into Angles, which if it do any where, you muſt mend

it in that place: Then with the edge of an *Half-round File*, File a ſmall line in that Black-Lead line, and be ſure that the line you are *Filing* run exactly through all the marks that the Black-Lead Pencil ſhould have run through (if it did not for want of good guidance of the hand) This ſmall line is only for a guide to cut the *Groove* down by; for the making of a *Screw* is indeed nothing elſe but the cutting the *Groove* down, for then the *Worm* remains: But you muſt not *File* in this ſmall line, but leave it as a guide to lye on the middle of the *Worm* (as I ſaid before): Therefore to cut down the *Groove*, take a *Cold-Chiſſel* ſomewhat thinner than you intend the *Groove* ſhall be wide, *viz.* about the thickneſs of the breadth of the *Worm*, and with heavy blows cut out the *Groove* pretty near. The reaſon why you ſhould not offer to cut the *Grooves* to their full width at the firſt, is, becauſe your Hand may carry the *Cold-Chiſſel* ſomewhat awry, and ſhould your *Cold-Chiſſel* be as thick as the *Groove* is wide, you could not ſmooth the Irregularities out without making the *Worm* narrower than you intended it: Then with a *Flat-file* open and ſmooth the *Grooves*, *Filing* in the middle between the two next fine lines cut by the *Half-round File*, till you have wrought the *Spindle* from end to end, ſo ſhall the *Worm* remain. But you muſt not expect that though the *Groove* be cut, it is therefore finiſhed, for you muſt now begin to uſe the thin *Plate-Gage*, and try firſt, whether the *Worm* have equal breadth all the way: ſecondly, whether the *Groove* have equal breadth all the way: and thirdly, whether the *Groove* have equal depth all the way; and where ever you find the *Worm* too broad, you muſt *File* it thinner; and where the *Groove* is not deep enough, *File* it deeper: therefore in cutting down the *Groove* you may obſerve, that if at firſt you *File* the *Worm* ne'er ſo little too narrow, or the *Groove* ne'er ſo little too deep, you ſhall have all the reſt of the *Worm* or *Groove* to *File* over again; becauſe the whole *Worm* muſt be wrought to the breadth of the ſmalleſt part of it,

and the whole *Groove* to the depth of the deepeſt place all the way, eſpecially if the *Nut* be to be *Caſt* in *Braſs* upon the *Spindle*; becauſe the Mettal running cloſe to the *Spindle* will bind on that place and not come off it: but if the *Nut* be not to be *Caſt* in *Braſs*, but only hath a *Worm Braz'd* into it, this niceneſs is not ſo abſolutely neceſſary, becauſe that *Worm* is firſt *Turned up* and bowed into the *Grooves* of the *Spindle*, and you may try that before it is *Braz'd* into the *Nut*, and if it go not well about, you may mend or botch it, either by *Hammering* or *Filing*, or both.

The manner of *Caſting* the *Nut* upon the *Spindle*, I ſhall ſhew when I come to the *Caſting* of *Mettals*: and the manner of *Brazing* hath been taught already, *Nnmb.* I. *Fol.* 12, 13.

If your *Spindle* is to have three or four *Worms* winding about it, as *Coyning-Preſſes* and *Printing Preſſes* have, that they may not wear out too faſt, you muſt devide the Circumference into three or four equal parts; and each of theſe equal parts into two equal parts, and having ſtraight upright lines, drawn as before, begin a *Worm* at each of thoſe three or four diviſions on the Circumference, and conſidering the breadth of your *Worm*, and width of your *Groove*, meaſure that width ſo oft as you can on all the upright lines, and making marks on thoſe, at each Setting off draw as before, a line from the end of the *Spindle* on the firſt upright line to the mark below it, which is the ſecond mark on the ſecond upright line, from thence to the third mark on the third upright line, and ſo on to the other end of the *Spindle*. Having drawn the firſt *Worm*, work the other *Worms* as this.

Thus much may at preſent ſuffice for *great Screws*; when I come to exerciſe upon *Printing*, I ſhall be more copious on Rules for *Printing-Preſs Spindles*.

# MECHANICK
# EXERCISES,

OR;

The Doctrine of

# Handy-works.

*From* Feb. 1. 1677. *to* March 1. 1677. *And is intended to be Monthly continued.*

By *Joseph Moxon* Hydrographer to the Kings Most Excellent Majesty.

*LONDON,*

Printed for *Joseph Moxon,* 1684.

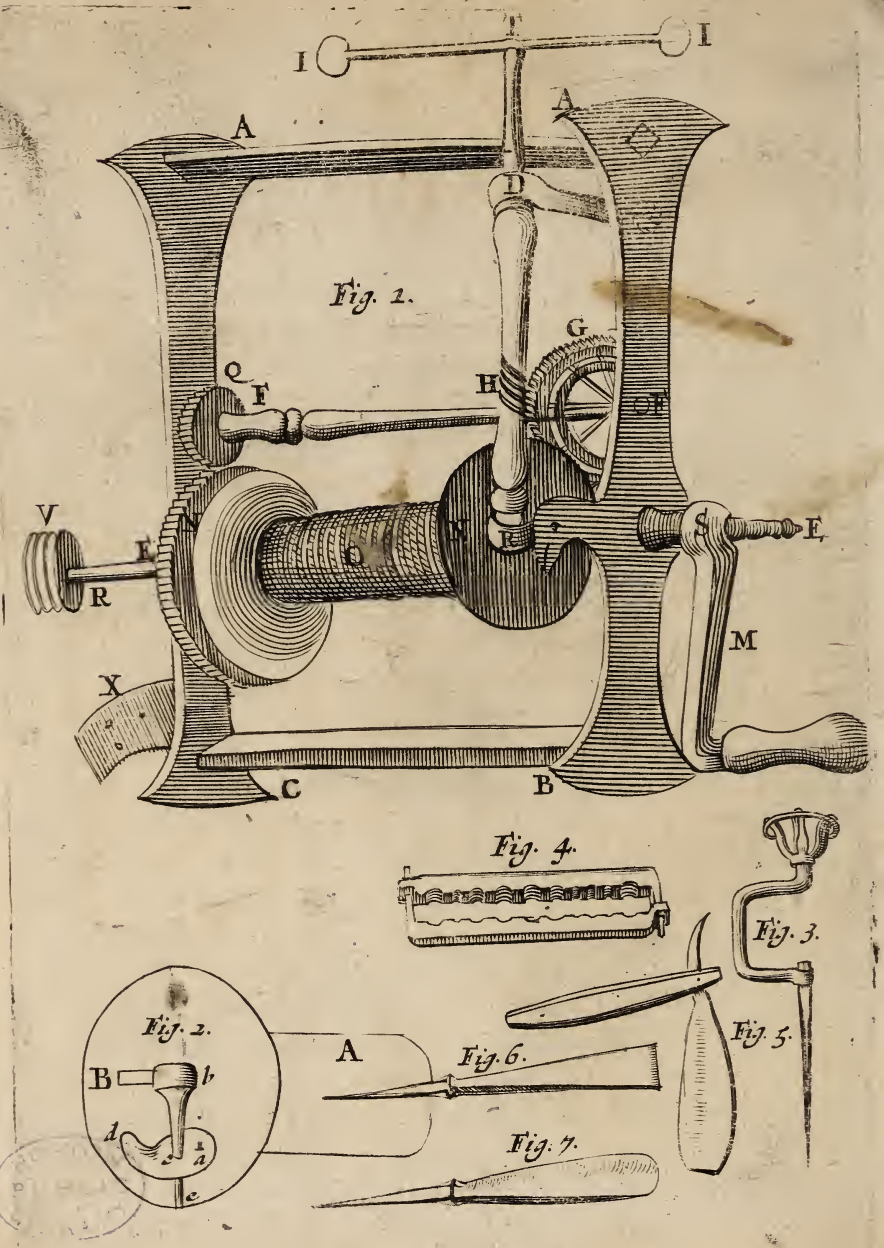


Fig. 1.
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Fig. 4.
Fig. 3.
Fig. 2.
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Fig. 6.
Fig. 5.
Fig. 7.

# MECHANICK EXERCISES, OR, The Doctrine of Handy-works.

Viz. *The making of Jacks, and Bullet-Molds, the twisting of Iron, and Case-hardning it, with the use of some Tools not treated of before: Also of the several sorts of Steel, the manner of Softning, Hardning, and Tempering them.*

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## *Of Jacks.*

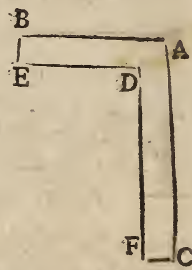
FIg. 1. is called a *Worm-Jack.* A B the *Fore-side,* A C the *Back-side*, A A the *Top-piece,* B C the *Bottom-piece,* altogether the *Jack-Frame,* E E K the *Main-Spindle,* N O N the *Main wheel* and *Barrel,* O the *Barrel,* D the *Wind-up-piece,* fastned into the *Barrel,* F F the *Worm-wheel-Spindle,* G the *Worm-wheel,* Q the *Worm-Nut,* H the *Worm,* R the *Stud* of the *Worm-Spindle,* D the *Worm-Loop,* L the *Wind-up-piece,* M the *Winch,* or *Winder,* or *Handle,* the Iron part is the *Winder,* the Wood the *Handle,* S the *Eye of the Winder,* I I the *Fly,* T the *Socket* of the *Fly,* V the *Struck-Wheel,* X the *Stayes,* or *Back-fastnings.*

First you are to Forge the *Jack-Frame,* and on the left side of the *Foreside* a Shank for the *Stud* of the *Worm-Spindle,* as you were taught, *Numb.* I. *Fol.* 8, 9, 10, 11, 12. and then File it, as you were taught, *Numb.* I. *Fol.* 14, 15, 16.

The *Top* and *Bottom Pieces* are let into square holes at the

ends of the *Fore* and *Backſides*. But you muſt Forge the *Top* and *Bottom-pieces* with two ſmall Squares towards the ends of them, and two round ends for *Screw-Pins*, beyond thoſe ſquares. The ſmall ſquares are to be fitted into ſquare holes into the *Fore* and *Backſides*, and the round *Screw-Pins* are to make *Screws* of, to which a ſquare *Nut* is to be fitted to draw the *Top* and *Bottom-Pieces* cloſe and tight up to the inſides of the *Fore* and *Backſides*. The manner of Filing of theſe ſquare ends you were in part taught, *Numb.* II. *Fol.* 15, 16. and *Numb.* I. *Fol.* 29. but another way is by trying your Work with an Inſtrument called by Workmen a *Square*, as you ſee deſcribed in this Figure.

### *Of the* Square *and its Uſe.*




The ſides A B C are called the *Outer-Square* : the ſides DEF the *Inner-Square*. Its uſe is thus: If your work (as in this caſe) be an *Outer-Square*, you muſt uſe the *Inner-Square*, DEF to try it by ; applying either the ſide ED, or DF (but ſuppoſe the ſide ED) to one of the ſides of your work: (chuſe the flatteſt and trueſt wrought ) if neither of the ſides be flat, make one of them flat, as you were taught, *Numb.* I. *Fol.* 15, 16. if then you find the ſide D F of your *Square* lye all the way even upon the adjoyning ſide of your work; you may conclude thoſe ſides are Square : but if the adjoyning ſide of your work comply not all the way with the adjoyning ſide of the *Square*, you muſt File away your work where the *Square* Rides upon it till the whole ſide be wrought to comply with the adjoyning ſide of the *Square*: that is, till both the ſides of your work agree with both the ſides of the *Squares* when they are applyed to one another. Having tryed two ſides ſquare, make a third ſide of your work ſquare, by applying one of the ſides of the *Square* to one

one of thoſe ſides of your work, that are already made ſquare and (as before) try the third un-tryed ſide, and make that Square: and by the ſame rule make the fourth ſide ſquare.

If the work you are to File be an hollow ſquare, you muſt apply the outer ſquare A B C to it, and try how, when one ſide of the *Square* is applyed to one ſide of your work, the other ſide of your work agrees with the other ſide of the *Square*; which if it do, all is well: but if the *Square* and the work comply not with one another, you muſt File your work where it bears the *Square* off. But to return where I left.

Having made theſe two ends ſquare, you muſt fit the length of them to the thickneſs of the *Fore* and *Backſides* into which they are to enter, but ſo as the ſquares be not full ſo long as to come quite through the *Fore* and *Backſides*, leſt when the *Nuts* are ſcrewed on the *Screw Pins* that are at the ends of theſe Squares, they ſcrew full up to the Squares, and bear againſt the corners of them: which if they do, the *Nuts* will not draw the *Fore* and *Backſides* cloſe againſt the ſhoulders of the ſquares, on the *Top* and *Bottom-Pieces*; and then the whole *Jack-Frame* will not ſtand faſt and firm together.

But before you fit this *Frame* thus together, you muſt conſider the Diameter of the *Main Wheel*, that you may Punch round Holes in the *Fore* and *Backſides* to enter the *Main-Spindle*: Therefore open your Compaſs to half the intended Diameter of the *Main-Wheel*, and half a quarter or an whole quarter of an Inch more for play, between the Semi-Diameter of the *Main Wheel*, and the upper flat of the *Bottom-Piece*, and ſet that diſtance off from the upper flat of the *Bottom-Piece*, on the *Fore* and *Backſides*, and with a round Punch, ſomewhat ſmaller than the intended ſize of the *Main-Spindle*, Punch Holes at that ſetting off. Your Punch muſt be ſmaller than the *Main-Spindle*, becauſe the holes may perhaps not be ſo exactly round, or Punched ſo truly upright or

perfectly

perfectly ſmooth as they ought to be; and ſhould you make the holes ſo wide at firſt as they need to be, you could not mend them without making them wider. Theſe holes muſt be punched at the *Fire* or *Forge* (as Smiths ſay, when they take an *Heat* of their work to punch it) becauſe the *Fore* and *Backſides* are *too ſtrong* (as Smiths ſay) that is, too thick to punch with the *Cold Punch.* The way of punching them you were taught *Numb.* I. *Fol.* 11,12. Beſides, a *Cold Punch* is commonly made flat at the bottom, and therefore does not prick an Hole, but cut an Hole (if the Iron be not too ſtrong) for that flat bottom and the round upright ſide about it meet in an Angle or Edge at the bottom, which edge by the force of an Hammer cuts the Iron (if it be not too ſtrong) when it is laid upon a *Bolſter,* as it is deſcribed, *Numb.* I. *Fol.* 12. and ſhould you cut out ſo much Iron in the *Fore* and *Backſides* as would entertain the *Main Spindle* (it being thick) you would make the *Fore* and *Backſides* too wide: therefore (as I ſaid, the Holes muſt be prickt in the *Fore* and *Backſides* at the *Fire* or *Forge*, which with a ſharp pointed *Punch* is ſooner done; nor does pricking diminiſh the ſubſtance or ſtrength of the Iron, but makes it ſwell out at the ſides, and retain both ſubſtance and ſtrength. The irregularity or ſwellings out that this punching makes on the flats of the *Fore* and *Backſides,* you muſt Hammer down again with almoſt a *Blood-Red Heat,* I ſay, almoſt a *Blood-Red Heat*; becauſe, ſhould you take too great an *Heat,* you may make the *Fore* and *Backſides* ſtretch, and ſo put the whole *Jack-Frame* out of order.

Having puncht the holes for the *Main Spindle,* you muſt punch the holes in the *Fore* and *Backſides* for the *Worm-Wheel Spindle,* as you puncht the Holes for the *Main Spindle*: But theſe muſt be ſmall Holes, to entertain the ſmall ends or *Pins* of the *Worm-Wheel Spindle.*

Theſe holes thus puncht, may perhaps not be exactly round, or fit your ſize, nor will they be ſmooth enough

within;

withal: Therefore with a [a] *Square Bore* you muſt [b] *open* them wider to your ſize, and that *opening* them in the inſide, will both round and ſmoothen them.

You muſt alſo Punch a ſquare Hole towards the top of the *Foreſide* for the *Shank* of the *Worm-Loop.*

Then Forge and fit in your *Main-wheel Spindle*, and your *Worm-Wheel Spindle*, which Spindles muſt both be exactly ſtraight between the centers of their two ends (unleſs you like to have Moldings for Ornaments on them) and Forge a ſquare towards the ends of both the Spindles to fit into a ſquare hole in the middle of the *Croſs* of their *Wheels*, and leave ſubſtance enough for a ſhoulder beyond the ſquare to ſtop the ſquare hole in the *Croſs* of the *Wheels* from ſliding further on the *Spindle*: and you muſt leave ſubſtance of Iron enough to Forge the *Nut* of the *Worm-wheel* near the other end. But in this, and indeed in all other forging, remember (as I told you *Numb.* I. *Fol.* 9.) that it behoves you to *Hammer* or *Forge* your work as true as you can, leaſt it coſt you great pains at the *Vice.*

Then forge the *Worm-Spindle*, which is all the way round and ſtraight, unleſs you will have Moldings for Ornaments (as aforeſaid) upon the *Shank* of it: But you muſt be ſure to Forge ſubſtance enough for the *Worm* to be cut out of it.

The *Main* and *Worm-Wheels* are Forged round and flat.

The manner of Forging theſe Wheels (which in Smiths Language is *Turning up the Wheels*) is, firſt, to draw out a Square Rod (as you were taught, *Numb* I *Fol* 9. among the ſeveral *Heats of Iron*) ſomewhat thicker than you intend your *Wheel* ſhall be: but it muſt be almoſt as thin on one ſide as you intend the Inner edge of the *Wheel* ſhall be, and the oppoſite to it above twice that thickneſs, for the outer Edge of the *Wheel*: (the reaſon you will find by and by:) Having drawn forth your ſquare Rod to a convenient length, *viz.* almoſt three times the Diameter of your intended Wheel, you muſt take almoſt a *Flame-Heat*, and Hammer all along the whole length upon the thick edge, ſo will



you

you find the long Rod by this Hammering turn by degrees rounder and rounder in upon the thin edge, which you Hammer'd not upon, till it become a Circle or pretty near a Circle. But you muſt make it ſomewhat more than a Circle, for the ends muſt lap over one another, that they may be *welded* upon one another.

Thus may you ſee the reaſon for making the outer edge of the Rod thick, and the oppoſite edge thin: for your Hammering upon the outer edge only, and not on the inner, makes the outer edge a great deal thinner, and at the ſame time makes the *Wheel* broader.

The reaſon why I told you, you ſhould draw forth the Rod to almoſt three times the Diameter of the Wheel, and not to the Geometrical proportion, is, becauſe that in Hammering upon it to make it round, the Rod will ſtretch ſo conſiderably, that it will be long enough to make a *Wheel* of your intended Diameter, and moſt commonly ſomewhat to ſpare. But to return.

Before you take a *welding Heat*, as by *Numb.* I, *fol.* 9, 10. you muſt flatten the two ends that are to be *welded* together to a little more than half their thickneſs, that when they are lapt over one another, and *welded* together, they may be no thicker than the other part of the *Wheel*.

If the *Wheels* be not *Turned up* ſo round, that with little labour you may mend them at the Vice, you muſt with *Blood red Heats* Hammer them round upon the *Pike* or *Bickern* of the *Anvil*, holding with your *Tongs* the inner edge of the *Wheel* upon it, and Hammering upon the outer edge of the *Wheel*, till the *Wheel* be fit for the *Vice*: Their inſides muſt be divided into four equal parts, or four c *Dufftail* notches to be filed into them. The *Dufftail* notches are cut in the inner edge of the *Wheel* towards the outer edge of the *Wheel*, ſomewhat more than a quarter of an inch deep, and ſpreading ſomewhat wider towards the outer edge. Theſe notches are to receive the four ends of a *Croſs* Forged ſome-

what

what thicker towards the ends than the thickneſs of the *wheel*, and muſt be filed outer *Dufftails*, to let exactly into the iner *Duftail* notches made in the inſide the *wheel*. They muſt be forged thicker than the *wheel*, becauſe they muſt batter over both the flat ſides of the *wheel*, to keep the *wheel* ſtrong and ſtedly upon the *Croſs*; and ſometimes (for more ſecurity) they are *brazed* into the *wheel* (yet that is but ſeldom:) the middle of this *Croſs* is made broad, that when the ſquare hole is made in the middle of it to receive the ſquare of the *Spindle*, it may have ſtrength enough to bear the violence offered it, as well in winding up the great weight, that keeps the *wheels* in motion, as in the checking and turning the *Jack-winder* back, to ſet the *Jack* a-going, when by the winding up it may be ſubject to ſtand ſtill, or ſometimes for want of weight, or elſe for want of oyling; or ſome other accident.

Theſe *wheels* thus forged and filed flat, muſt be divided, the *Main wheel* commonly into 64 equal parts, and the *Worm-wheel* into about thirty two equal parts : but theſe numbers are not exactly obſerv'd by Smiths, for ſometimes they make them more and ſometimes leſs, either according to the ſize of their *wheels*, or according as they intend their *wheels* ſhall go ſwifter or ſlower about (for the fewer the *Teeth* on a *wheel* are, the ſooner a *wheel* goes about, and the more *Teeth* on a *wheel*, the ſlower the *wheel* goes about ) or ſometimes as they have opened their Compaſſes to divide them : For if by luck they at firſt open their Compaſſes to ſuch a width as will juſt meaſure out on a Circle (which they deſcribe on the center of the *wheel* for that purpoſe) their intended number, then the *wheel* ſhall have the intended number of *Teeth*; if not, let it ſomewhat fall ſhort or exceed that number they matter not, but make that number of *Teeth* on the *wheel*. And having thus divided the *wheel*, they by the ſide of a ſtraight Ruler laid to the center, and every diviſion markt on the *wheel*, draw or ſcratch a ſtraight line from the outer limb of the *wheel* to the circle, which circle (I ſhould have

told you before) is described at that distance from the outer Verge they intend the *Teeth* shall be cut down to. This is indeed a rough way of working, but the Office of a *Jack* is well enough performed by this rough work; and the usual prizes such, as will scarce pay workmen for better, as they say.

These *Wheels* thus divided, must be cut down into these divisions with a [d] *Jack-file*, the *Main-Wheel* straight athwart the outer Verge, (which to speak Mathematically makes an Angle of 90 degrees with the flat sides of the *Wheel*,) and the *Worm-Wheel* aslope, making an Angle of about 115 degrees with its sides, that is, and Angle of 25 degrees with a line drawn straight athwart the outer Edge of the *Wheel*, that the *Teeth* of the *Worm-Wheel* may gather themselves into the *Grooves* of the *Worm* in the *Worm Spindle*; the *Worm* on the *Worm-Spindle* running about 65 degrees aslope ftom the Azis or perpendicular of the *Worm-Spindle*; The notches you make with the File must be so wide, as to contain about twice the thickness of each *Tooth*: Therefore you may observe that the number of *Teeth* cannot be assign'd, because the sizes of all *Jack-Wheels* are not of equal Diameters, and the sizes of the *Teeth* must be Filed very square and smooth, and the corners taken off, and rounded on both sides towards the middle of the top or end of the *Tooth*, wich much helps the *Teeth* to gather in upon the *Teeth* of the *Nut*, and the *Worm* on the *Worm-Spindle*.

The *Teeth* of the *Wheels* being cut down, and the whole *Wheel* finished, they must be forced stiff and hard upon the Square of the *Spindle*, close up to the Shoulder; which Square being made somewhat longer than the *Cross* of the *Wheel* is thick, must with a *Cold Chissel* be cut on the top of that Square, to make the Iron that comes through the Square hole of the *Wheel* spread over the *Cross* of the *Wheel*, and then that spreading must be battered with the *Pen* of the Hammer; that it may stand up stiff against the Shoulder of the square on the other side of the *Wheel*: But in doing this, you must be very careful that the *Spindle* stand exactly perpendicular to the flat

sides.

ſides of your *Wheels*;for ſhould the *Spindle* lean never ſo little to one or the other ſide of the *Wheel*, the *Wheel* when it is moving in the *Jack-frame* would not move perpendicular but wabble towards the *Fore* or *Backſides* of the *Jack-frame*,and perhaps by this iregular motion,before a revolution of the *wheel* be performed,it would go off from the length of the *Teeth* of the *Nut*.

Then File the *Spindle-Pins* (which are the ends of the *Spindle*,that go into the center-holes of the *Foce* and *Backſides* of the *Jack-Frame*) exactly round and fit to their center holes, and place them into their proper center holes. Then try if the *Wheels* are exactly round on their outer edges,and that in turning about,their flat ſides wabble not,but in a revolution keep parralel to the *Fore* and *Backſides*: The way Smiths uſe to try them by,is to turn them about by the *Spindle*, and holding a piece of Chalk ſteddy to the outer Limb of the *Wheel*, not leting the point of the Chalk ſlip forwards or backwards, or towards the right or left hand, for then if the Chalk make a white ſtroke round the whole *Wheel*,and that white ſtroak lye exactly parallel to the two outer Edges of the *Wheel*,the *Wheel* is not only round,but ſtands alſo true upon its *Spindle*, (that is) perpendicular to the *Spindle*, and the *Spindle* perpendicular to the flat of it: But if the Chalk does not touch round the whole *Wheel*, you muſt File down ſo much of the outer Verge of the *Wheel*, where the Chalk does touch, as will bring down or equalize the Diameter of the *Wheel* in that place to the Diameter of the *Wheel* in the place where it does not touch;ſo may you conclude the *Wheel* is round. If the mark of the Chalk lye not exactly in the middle between the two edges of the *Wheel*,then it is not perpendicular to the *Spindle*, and you muſt with the Hammer ſet it right, that is, perpendicular, by forcing the *Wheel* over from the ſide it leans too much to, or elſe by forcing the *Spindle*, which is all one; yet this is an help you ought not to rely upon, to uſe, but in caſe of neceſſity,but rather be ſure your *Wheel* and *Spindle* ſtand perpendicular to one another before you faſten

the *Wheel* upon the ſquare of the *Spindle*, for by this help the ſquare on the *Spindle* will be apt to looſen in the ſquare of the *Wheel*, and you will have your *Wheel* to new faſten upon the ſquare of the *Spindle* again.

As you tryed the *Wheels* with Chalk, ſo you muſt try the *Nut*, the *Worm*, and the *Spindles*.

The upper part of the *Worm Spindle* muſt be filed truly round to fit into the *Worm-Loop*, that it ſhake not in it, and yet go very eaſily about, without the leaſt ſtopping. At the very upper end of this round on the *Worm-Spindle* you muſt file a ſquare to fit the ſquare hole of the *Fly* upon.

The *Shank* of the *Worm-Loop*, and the *Stud* of the *Worm Spindle* muſt ſtand ſo far off the left ſide of the *Fore ſide*, that the *Teeth* of the *Worm wheel* may fall full into the *Grooves* of the *Worm*; for ſo, both being cut with the ſame ſlope, the ſlope *Teeth* of the *Worm-wheel* will gather into the ſlope *Grooves* of the *Spindle*, and preſſing upon the *Worm* drive about the *Worm Spindle* and the *Fly*.

The *Fly* is made ſometimes with two, ſometimes with four Arms from the center: and ſometimes the Arms are made longer, ſometimes ſhorter: The more Arms, and alſo the longer Arms, are to make the *Jack* go ſlower.

There is yet a ſmall matter more of Iron work about the *Jack*, which is the *Tumbler*; but it lies in the further end of the *Barrel*, and cannot well be deſcribed without a particular figure, which therefore I have inſerted. As in *Fig.* 2. A the *Barrel*, B the *Main Spindle* coming through the *Barrel*, *a* the center of the *Tumbler* moving upon the *Center-pin*, which is faſtened into an Iron plate behind the *Barrel*. *b* The *Coller* upon the *Main Spindle*, from which proceeds a *Tongue*, which paſſes through a pretty wide hole at *c* in the *Tumbler*, as far as *e* *d* the *Catch of the Tumbler*. The *Tumbler* moves (as aforeſaid) upon the center hole *a*, but receives the *Tongue* through it at *c*, and paſſes as far as *e*. This *Tongue* ſerves as a *Check* to the *Tumbler*, that it cannot tumble above an

Angle

Angle of 20 degrees from the Iron plate it is faſtened to; and that the width of its center hole, and the width of the hole the *Tongue* paſſes through, and the motion of the *Coller* about the *Main Spindle* allows it; but were the center hole *a*, and its *Center pin* fit, and the hole *c* and the *Tongue* that paſſes through it alſo fit, and the *Coller* fixt, it could not move at all. But this play is enough for it to do the purpoſe it is deſigned for. The *Tumbler* is ſo placed behind the *Barrel*, that while the *Jack-line* is winding up upon the *Barrel*, its round britch paſſes forwards by all the *Croſſes* of the *Main Wheel*, and the point or *Catch d*, as then claps it ſelf ſnug or cloſe to the Iron plate of the *Barrel*: But when the *Barrel* is turned the contrary way, the weight of the *Catch* in half a revolution of the *Barrel* (let the *Tumbler* be poſited where it will) makes it open and fall from the Iron plate, and butt againſt one or other of the *Croſſes* on the *Main Wheel*, and ſo thruſts the *Main Wheel* about with the *Barrel*.

The *Eye* of the *Winch* or *Winder* is Forged as you were taught to forge the *Pin-Hole* in the *Croſs-garnet, Numb.* II *fol.* 18. But that was to be a ſmall round hole, and therefore you were directed to lay a ſmall round piece of Iron or Wyre where you intended the Pin Hole ſhould be, and lap the other end of your work over it; But this is to be a wide ſquare hole, therefore you muſt lay a ſquare piece of Iron of your ſize, where the *Eye* of the *Jack-Winch* ſhall be, and lap or double the other end over it, and *Weld* and Work as you were there directed. The reſt of the *Winch* is but common *Forging* and *Filing* work, which hath been ſufficiently taught already.

The Wood work belonging to a *Jack*, is a *Barrel*, a *Spit-wheel*, and a *Handle of the Winch*; which being *Turners* work I ſhall ſay nothing to, till I come to the Art of *Turning*. Only thoſe *wheels* that have more than one *Groove* in them are called Two, Three, &c. *Struck-wheels* in Workmens corrupting language; But, I ſuppoſe, originally two *Stroak*, three *Stroak-*

*Wheels*

*Wheels*, &c. from the number of *Grooves* that are in them.

The Excellencies of a good *Jack* are (1.) That the *Jack-Frame* be Forged and Filed ſquare, and conveniently ſtrong, well ſet together, and will ſcrew cloſe and tight up. (2.) That the *Wheels* be perpendicularly and ſtrongly fixed on the ſquares of the *Spindles*. (3.) That the *Teeth* be evenly cut, and well ſmoothed, and that the *Teeth* of the *Worm Wheel* fall evenly into the *Groove* of the *Worm*. (4.) That the *Spindle-Pins* ſhake not between the *Fore* and *Backſides*, nor are too big or too little for their Center holes.

The *Square-Bore* is a ſquare Steel Point or Shank, well Temper'd, fitted into a ſquare Socket in an Iron *Wimble*: It is deſcribed, *Fig*. 3. Its uſe is to open a Hole, and make it truly round, and ſmoooth within; when you uſe it you muſt ſet the Head againſt your Breaſt, and put the point of the *Square-Bore* into the Hole you punched or would *open*, and turning the Handle about, you with it turn about the Shank of the *Square Bore*, whoſe edges cut away the irregularities of the Iron made in the Punchiug. But you muſt thruſt or lean hard with your Breaſt againſt the Head of the *Square-Bore*, that it may cut the faſter: And you muſt be ſure to guide the *Square-Bore* truly ſtraight forwards in the Hole, leaſt the Hole be wrought aſlope in the Iron.

b To *open an Hole*, is in Smiths Language to make the Hole wider.

c A *Dufftail* is a figure made in the form of a Doves-tail, and is uſed by many other Handicrafts as well as by Smiths, but moſt eſpecially by Joyners, as I ſhall ſhew, when I come to *Joynery*.

d A *Jack-File* is a broad File ſomewhat thin on both Edges, and ſtronger in the middle.

*The manner of making Molds to Caſt Leaden Bullets in.*

I inſert the making of *Bullet-Molds*, becauſe there is ſome ſort of Work in them different from what hath yet been taught. The Handles and the Head are Forged as other Work, but the

two

two concave Hemiſpheres are firſt punched with a round ended *Punch*, of the ſhape and almoſt of the ſize you intend the *Bullet* ſhall be. They muſt be punch'd deep enough at the *Forge* with a *Blood-red Heat*: Then are the Edges of the Chaps Filed flat, firſt with a Common File the Common way, but afterwards with an *Uſing-File*, as Workmen call it: The *Uſing-File* is a long and broad File exactly flat on both its cut ſides, having a ſquare Iron Handle drawn out at one end with an hole in it; but the handle is not to hold it by, when you uſe it, but the hole in it to go over a pin you hang it upon, when you do not uſe it. When you uſe it, you muſt lay it flat upon the Work-bench, with its handle from you, and you muſt take care that it lye ſolid and ſteddy, leſt when you work upon it, it ſlip from you; therefore you may ſtrike a Nail in at the hole in the Handle, a little way into the Work-Bench, that you may draw it again, when you have done with the *Uſing File*, and you may drive in a ſmall Tack on each ſide the *Uſing-File*, to keep it ſteddy, or you may Tack down two ſmall thin boards on either ſide the *Uſing File*, to keep it ſteddy, and rip them off again when you have done. Your *Uſing-File* lying thus ſtraight and ſteddy before you, lay the Chaps of one half of the *Mold* flat upon the hither end of the *Uſing-File*, and holding your two Thumbs, and your two Fore-Fingers upon the Head of the *Mold*, thruſt your work hard down from you the whole length of the *Uſing-File*, then draw your work lightly back, and thruſt it again hard from you; reiterate theſe thruſts, thus till upon the Chaps of the *Mold*, you can ſee no irregularities, or the File ſtroaks of the common File left, ſo may you be ſure that the Chaps of the *Mold* is truly flat. Do the like by the other half of the *Mold*.

Now you muſt try whether each of theſe concaves be an exact half-round; thus, you may deſcribe an Arch a little more than a Semi-Circle, juſt of the Diameter of your *Bullet* upon the end of a thin piece of Braſs latin, draw a ſtraight line

through the Center and the Arch on both ſides it, for the limits of a Semi-Circle: File very curiouſly all the Braſs away on the end juſt to this Semi-Circle, and juſt to the Diametral line on either ſide the Semi-Circle, ſo have you a convex Semi-Circle: Put this convex Semi-Circle into the concave *Molds,* if it fits them ſo as the convex reaches juſt the bottom of the *Molds,* when its ſhoulder touches juſt the chaps of the *Mold,* they are each a true concave Hemiſphear. But if the Shoulder of the convex (that is a Diametral line prolong'd) rides upon the chaps of the Concave, and the bottom of the convex touch not the bottom of the concave, the concave is punched too deep, and muſt have its chaps rubb'd upon the *uſing File* again, till it comply with the convex. Then put into the two concaves a round *Bullet,* that will juſt fill them both, and pinching the Heads of the *Mold* cloſe together in a *Vice,* with the *Bullet* in it, drill an Hole through both the Handles for the *Joynt.* The reaſon why the *Bullet* is put into the *Mold,* is becauſe the Chaps of the two Halves ſhould lye exactly upon one another, while the hole for the *Joynt* is drilling. Then fit a Rivet pin for this hole, and Rivet them together, but not ſo hard but that the may open and ſhut pretty eaſy, and yet go true. Then take the *Bullet* out, and file in each half of the Head half a round hole directly againſt one another for the a *Geat,* which two Half holes, when the *Mold* is ſhut, will make one round hole.

You may now try with Clay, or by caſting a leaden *Bullet* in it, whether it be exactly round or no; for making a true round hole in a thin piece of Braſs, juſt of the circumference of the chaps, you may try if the *caſt Bullet* will juſt paſs through, and alſo fill that hole when the Bullet is turned every way: which if it do, you may conclude the *Mold* is true. This thin piece of Braſs, with a round hole in it, is called a *Sizer.*

But the inſide wants cleanſing, for hitherto it is only punched. Therefore you muſt provide a b *Bullet-Bore,* with which you may bore the inſide of each half to clear it. Or if they

be

be not quite deep enough punch't, you may bore them deeper. You may bore them severally, or together, by putting the *Bullet-Bore* into the *Mold*, so as the *Shank* may come through the *Geat*.

In this Section you see, first the use of a *Using File*, an Instrument of great use for flat Filing; for by it you may make two pieces of Iron of somewhat considerable breadth, so true, that by laying the two flat sides upon each other, they shall draw up one another. It is much used by *Clock-makers*, *Watch-makers*, *Letter-Mold Makers*, and indeed all others that Frame square work on Iron, Steel or Brass. Secondly, the use of a *Bullet-Bore*, which, though it be seldom used, yet it may serve, not only for *Bullet-Molds*, but for other purposes: and by altering its shape into an Oblong, a Cone, or a Cilinder, you may *Bore* these hollow Figures either for *Molds*, or some other accidental uses.

[a] A *Geat* is the hole through which the Mettal runs into the *Mold*. The Word is used by most *Founders*.

[b] The *Bullet-Bore* is a *Shank* of Steel, having a Steel Globe or *Bullet* at one end, just of your intended *Bullets* size. This Globular end must be hatched with a fine-cut, by a *File-Cutter*, and Hardned and Tempered. The end of the *Shank* this Globular *Bore* is fastned to must be round and so small that when the *Bullet-Bore* is in the *Mold* the *Geat* will easily receive it. The other end of the *Shank* must be fitted into the Square Socket of the *Wimble*, and have a Shoulder to it, to stop the Socket from sliding too far upon the *Shank*; From this Shoulder the rest of the *Shank* must run tapering down to the small end the *Bullet-Bore* is fastned to. You must work with it as you were taught to work with the *Square Bore*.

### *Of Twisting of the Iron.*

Square and flat Bars sometimes are by Smiths *Twisted* for Ornament; It is very easily done; for after the Bar is square or flat Forged (and if the curiosity of your work require it truly Filed) you must take a *Flame-Heat*, or if your work be small but a *Blood-Red Heat*, and you may twist it about, as much or

as little as you pleaſe, either with the *Tongs*, *Vice*, or *Hand-Vice*, &c.

### *Of Caſe Hardning.*

*Caſe Hardning* is ſometimes uſed by *File-Cutters*, when they make courſe *Files* for Cheapneſs, and generally moſt *Raſps* have formerly been made of Iron and *Caſe-Hardned*, becauſe it makes the outſide of them hard. It is uſed alſo by *Gun Smiths* for hardning their Barrels: And it is uſed for *Tobacco Boxes*, Cod-piece Buttons, Heads for walking Staves, &c. And in theſe Caſes workmen, to ſet a greater value on them in the Buyers eſteem, call them *Steel Barrels*, *Steel Tobacco- Boxes*, *Steel Buttons Steel Heads*, &c. But Iron thus hardned takes a better Polliſh, and keeps the Polliſh much longer and better, than if the Iron were not *Caſe-Hardned*. The manner of *Caſe Hardning* is thus. Take *Cow-Horn*, or *Hoof*, dry it throughly in an Oven, and then beat it to Powder, put about the ſame quantity of Bay-Salt to it, and mingle them together with ſtale Chamberley, or elſe with White-Wine-Viniger. Lay ſome of this mixture upon Loam, made as you were taught, *Numb* I. *Fol.* 13. And cover your Iron all over with it ; then wrap the Loam about all, and lay it upon the Hearth of the Forge to dry and harden: when it is dry and hard, put it into the Fire, and blow up the Coals to it, till the whole Lump have juſt a Blood-Red-Heat, but no higher than a Blood-Red-Heat, leaſt the quality of your mixture burn away, and leave the Iron as ſoft as at firſt: Then take it out and quench it. Or inſtead of Loam you may wrap it up in Plate Iron, ſo as the mixture may touch every part of your Work, and blow the Coals to it, as aforeſaid.

### *Of ſeveral ſorts of Steel in common uſe among* Smiths.

The difficulty of getting good Steel makes many Workmen (when by good hap they light on it) commend that Country Steel for beſt from whence that Steel came. Thus I have found ſome cry up *Flemiſh Steel*, others *Swediſh-Steel*, others *Engliſh*, *Spaniſh*, *Venice*, &c. But according to my obſervation,

and

and the common consent of the most ingenious Workmen, each Country produces almost indifferently good and bad; yet each Country doth not equally produce such Steel as is fit for every particular purpose, as I shall shew you by and by. But the several sorts of Steel, that are in general use here in *England*, are the *English Steel*, the *Flemish*, the *Swedish*, the *Spanish*, and the *Venice Steel*.

The *English Steel* is made in several places in *England*, as in *York-shire*, *Glocestershire*, *Sussex*, the *Wild of Kent*, &c. But the best is made about the *Forrest of Dean*; it breaks Fiery, with somewhat a course Grain: But if it be well wrought, and proves sound, it makes good Edge-Tools, Files and Punches. It will work well at the Forge, and take a good Heat.

The *Flemish-Steel* is made in *Germany* in the Country of *Stiermark*, and in the *Land of Luyck*: From thence brought to *Colen*, and is therefore sometimes called *Colen Steel*: From *Colen* it is brought down the *River Rhine* to *Dort* and other parts of *Holland* and *Flanders*, some in Bars, and some in *Gads*, and is therefore by us called *Flemish Steel*, and sometimes *Gad Steel*. It is a tough sort of Steel, and the only Steel used for Watch Springs. It is also good for Punches, File-Cutters also use it to make their Chissels of, with which they Cut their Files. It breaks with a fine Grain, works well at the Forge, and will take a welding Heat.

I cannot learn that any Steel comes from *Sweden*, but from *Dantzick* comes some which is called *Swedish Steel*: It is much of the same quality and fineness with *Flemish Steel*.

The *Spanish Steel* is made about *Biscany*. It is a fine sort of Steel, but some of it very difficult to work at the Forge, because it will not take a good Heat; and it sometimes proves very unsound, as not being well *Curried*, that is well wrought. It is too quick (as Workmen call it) that is, too brittle for Springs or Punches, but makes good fine Edged Tools.

*Venice Steel* is much like *Spanish Steel*, but more fine, and works somewhat better at the Forge. It is used for Raizors,

Chirurgions Instruments, Gravers, *&c.* Because it will come to a fine and thin Edge. Raizor-makers generally clap a small Bar of *Venice Steel* between two small Bars of *Flemish Steel*, and so work or weld them together, to strengthen the back of the Raizor, and keep it from cracking.

There is another sort of Steel of higher commendations than any of the foregoing sorts. It is called *Damascus Steel*: It is very rare that any comes into *England* unwrought, but the *Turkish* Symeters are generally made of it. It is most difficult of any Steel to work at the Forge, for you shall scarce be able to strike upon a Blood Heat, but it will *Red Sear*; insomuch that these Symeters are by many Workmen thought to be cast Steel. But when it is wrought it takes the finest and keeps the strongest Edge of any other Steel. Workmen set almost an inestimable value upon it, to make Punches, Cold Punches, *&c.* of. We cannot learn where it is made, and yet as I am informed, the Honourable Mr. *Boyl* hath been very careful and industrious in that inquiry; giving it in particular charge to some Travellers to *Damascus* to bring home an account of it: But when they came thither they heard of none made there, but were sent about fifty miles farther into the Country, and then they were told of about fifty Miles farther than that: so that no certain account could be gained where it is made. *Kirman* towards the Ocean affords very fine Steel, of which they make Weapons highly prized: for a Symeter of that Steel, will cut through an *Helmet* with an Easy blow. *Geog. Rect. Fol.* 279.

### *The Rule to know good Steel by.*

Break a little piece of the end of the Rod, and observe how it breaks: for good Steel breaks short off; all Gray, like frost work Silver. But in the breaking of the bad you will find some veins of Iron shining and doubling in the Steel.

### *Of Nealing of Steel.*

Having chose your Steel, and forged it to your intended shape, if you are either to File upon it, or Engrave upon it, or to Punch upon it, you ought to Neal it first, because it will

make

make it ſofter, and conſequently work eaſier. The common way is to give it a Blood-Red Heat in the Fire, then take it out, and let it Cool of it ſelf.

There are ſome pretenders to know how to make Steel as ſoft as Lead: But ſo oft as my curioſity has prompted me to try their pretended proceſſes, ſo oft have they failed me; and not only me, but ſome others, Careful Obſervers. But the Way they moſt boaſt of, is the often heating the Iron or Steel in Red-Hot-Lead, and letting it cool of it ſelf, with the Lead. I have many times tryed this without any other ſucceſs than that it does indeed make Iron or Steel as ſoft as if it were well Neal'd the common way, but no ſofter: And could it be otherwiſe, the ſmall Iron Ladles, that Letter-Founders uſe to the caſting of Printing-Letters, would be very ſoft indeed; for their Iron Ladles are kept conſtantly Month after Month in melted Mettal, whereof the main Body is Lead, and when they Caſt ſmall Letters they keep their Mettal Red hot; and I have known them many times left in the Mettal, and cool with it as the Fire has gone out of it ſelf; but yet the Iron Ladles have been no ſofter than if they had been well Neal'd the common way. But perhaps theſe pretenders mean the Iron or Steel ſhall be as ſoft as Lead, when the Iron or Steel is Red-Hot: If ſo, we may thank 'um for nothing.

But that which makes Steel a very ſmall matter ſofter than the common way of Nealing is, by covering the Steel with a courſe Powder of Cow-Horns or Hooves, or Rams-Horns, and ſo incloſing it in a Loam; then put the whole lump into a wooden Fire to heat Red hot, and let it lye in the Fire till the Fire go out of it ſelf, and the Steel cool with the Fire.

### *Of Hardning and Tempering Steel.*

*Engliſh, Flemiſh*, and *Swediſh Steel* muſt have a pretty high heat given them, and then ſuddenly quench'd in water to make them very hard; but *Spaniſh* and *Venice Steel*, will need but a Blood-Red-Heat, and then when they are quenched in Water will be very hard. If your Steel be too hard, that is too brittle, and it be

an edged or pointed Inſtrument you make, the edge or point will be very ſubject to break: Or if it be a Spring it will not bow, but with the leaſt bending it will ſnap aſſunder: Therefore you muſt *let it down*, (as Smiths ſay) that is, make it ſofter, by *Tempering* it. The manner is thus, take a piece of Grinſtone or Whetſtone, and rub hard upon your work to take the black ſcurff off it, and brighten it: then let it heat in the Fire, and as it grows hotter you will ſee the Colour change by degrees, coming firſt to a Light Goldiſh Colour, then to a darker Goldiſh Colour, and at laſt to a Blew Colour: Elect which of theſe Colours your work Requires, and then quench it ſuddenly in Water. The *Light Goldiſh Colour* is for *Files, Cold Chiſſels,* and *Punches* that Punch into Iron or Steel: The *Dark Goldiſh Colour* for Punches to uſe on Braſs, and generally for moſt *Edge-Tools*: The *Blew-Colour* gives the Temper to *Springs* in general, and is alſo uſed to beautifie both Iron and Steel: but then Workmen ſometimes grind *Indico* and *Sallad-Oyl* together, and rub that mixture upon it, with a woollen Rag while it is heating, and let it Cool of it ſelf.

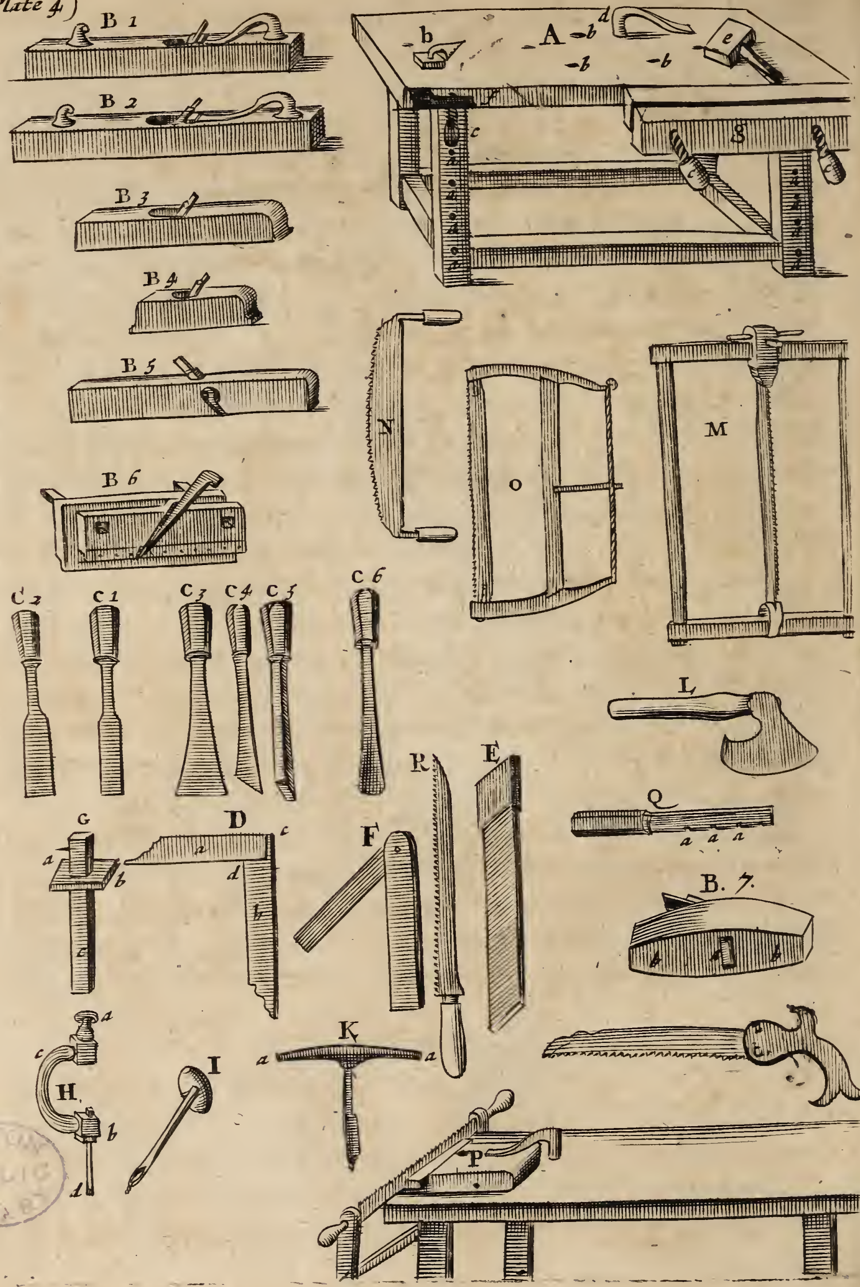
There is another ſort of *Hardning*, called *Hammer Hardning*. It is moſt uſed on Iron or Steel Plates, for *Dripping-Pans, Saws, Straight-Rulers,&c.* It is performed only, with well Hammering of the Plates, which both ſmooths them, and beats the Metal firmer into its own Body, and ſo ſomewhat hardens it.

The manner of Forging Steel, either for *Edge Tools, Punches, Springs,* &c. Is (the ſeveral ſhapes conſidered) the ſame with Forging Iron: Only this General Rule obſerve from an Old Engliſh Verſe uſed among *Smiths*, when they Forge *Edge-Tools.*

*He that will a good Edge win,*
*Muſt Forge thick, and Grind thin.*

**FINIS.**

Plate 4)



# MECHANICK
# EXERCISES,

OR,

The Doctrine of

# Handy-works.

*From* April *the* 1. *to* May *the* 1. 1678. *And is intended to be Monthly continued.*

By *Joseph Moxon* Hydrographer to the King's most Excellent Majesty.

*LONDON,*
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# *MECHANICK EXERCISES.* OR, The Doctrine of *Handy-works.*

## The Art of *Joynery.*

### *Definition.*

JOynery *is an Art Manual whereby ſeveral Pieces of Wood are ſo fitted and joyned together* by ſtraight Lines, Squares, Miters, *or any* Bevel, *that they ſhall ſeem one intire Piece.*

### *Explanation.*

By *ſtraight Lines* I mean that which in Joyners Language is called a *Joynt*, That is, Two Pieces of Wood are *Shot* (that is Plained,) or elſe they are *Pared*, that is, the irregularities that hinder the cloſing of the two Pieces are cut off with a *Paring Chiſſel.* They are *Shot* or *Pared* (as I ſaid) ſo exactly ſtraight, that when they are ſet upon one another light ſhall not be diſcerned betwixt them. This they call *Shooting of a Joynt*, or *Paring to a Joynt*, becauſe theſe two Pieces are with Glew commonly joyned together, either to make a Board broad enough for their purpoſe, or to [a] *Clamp* one piece of wood to the end of another piece of wood to keep it from *caſting* or *warping*.

By *Squares* I mean the making of *Frames*, either for *Door-caſes*, or ſuch like, which is the Framing

of two pieces of wood athwart two other pieces of wood, ſo as the four Angles of the *Frame* may comply with the *Square*, marked D.

By *Miters* are meant the joyning of two pieces of wood, ſo as the Joynt makes half a Square, and does comply with the *Miter Square*, marked E.

By a *Bevil* is meant any other Angle: As Frames that may be made of *Pentagon*, *Hexagon*, *Octagon*, &c. Figures.

## § 1. The Names of *Joyners Tools* deſcribed. In *Plate* IIII.

A *A Work-Bench*. *b* The *Hook* in it, to lay Boards or other [b] *Stuff* flat againſt, whiles they are [c] Trying or Plaining. *c* The Bench-Screw (on its hither ſide) to Screw Boards in whiles the edges of them are Plaining or [d] *Shooting*; and then the other edge of the Board is ſet upon a *Pin* or *Pins* (if the Board be ſo long as to reach to the other *Leg*) put into the *Holes* marked *a a a a* down the *Legs* of the *Bench*; which *Pin* or *Pins* may be removed into higher or lower *Holes*, as the breadth of the Board ſhall require: So then, the *Bench-Screw* keeps the Board cloſe to the edge of the *Bench*, and the *Pins* in the *Legs* keep it to its height, that it may ſtand ſteddy whiles the other edge is working upon: For in the *Shooting* of a *Joynt*, if the Board keeps not its exact poſition, but ſhakes or trembles under the *Plain*, your *Joynt* will very hardly be truly ſtraight. *d* The *Hold faſt*, let pretty looſe into round holes marked *b b b b b b*, in the *Bench*: Its office is to keep the work faſt upon the *Bench* whiles you either *Saw*, *Tennant*, *Morteſs*, or ſometimes *Plain* upon it, &c. It performs this office with the knock of an *Hammer*

*mer* or *Mallet* upon the *head* of it; for the *Beak* of it being made crooked downwards, the end of the *Beak* falling upon the flat of the *Bench* keeps the *Head* of the *Hold-fast* above the flat of the *Bench*, and the *hole* in the *Bench* the *Shank* is let into being bored straight down and wide enough to let the *Hold-fast* play a little, the *Head* of the *Hold-fast* being knockt, the point of the *Beak* throws the *Shank* aslope in the *hole* in the *Bench*, and presses its backside hard against the edge of the *Hole* on the upper Superficies of the *Bench*, and its Foreside hard against the opposite side of the under Superficies of the *Bench*, and so by the point of the *Beak* the *Shank* of the *Hold-fast* is wedged between the upper edge and its opposite edge of the round hole in the *Bench*. Sometimes a *double Screw* is fixed to the side of the *Bench* as at *g*: or sometimes its farther *Cheek* is laid an edge upon the flat of the *Bench*, and fastned with an *Hold-fast*, or sometimes two on the *Bench*. *e* A *Mallet*.

§ 2. BBBBBBB *Plains* of several sorts: as,

B 1 *A Fore Plain*. *a* The *Tote*. *b* The *Mouth*. *c* The *Wedge*. *d* The *Iron*. *e* The *Sole*. *f* The *Fore-end*, *g* The *Britch*. *f g h* The *Stock*. All together *A Plain*. It is called the *Fore Plain* because it is used before you come to work either with the *Smooth Plain* or with the *Joynter*. The edge of its *Iron* is not ground upon the straight, as the *Smooth Plain* and the *Joynter* are; but rises with a Convex Arch in the middle of it; for its Office being to prepare the *Stuff* for either the *Smoothing Plain* or the *Joynter*, Workmen set the edge of it e *Ranker* than the edge either of the *Smoothing Plain* or the *Joynter*; and should the *Iron* of the *Plain* be *ground* to a straight edge, and it be set

never ſo little *Ranker* on one end of the edge than on the other, the *Ranker* end would (bearing as then upon a point) in working dig Gutters on the Surface of the *Stuff*; but this *Iron* (being *ground* to a Convex Arch) though it ſhould be ſet a little *Ranker* on one end of its edge than on the other, would not make Gutters on the Surface of the *Stuff*, but (at the moſt but) little hollow dawks on the *Stuff*, and that more or leſs, according as the *Plain* is *ground* more or leſs arching. Nor is it the Office of this *Plain* to *ſmooth* the *Stuff*, but only (as I ſaid) to prepare it, that is, to take off the irregular Riſings, whether on the ſides or in the middle, and therefore it is *ſet* ſomewhat *Ranker*, that it may take the irregularities the ſooner off the *Stuff*, that the *Smoothing Plain* or the *Joynter* may afterwards the eaſier work it *Try*, The manner of *Trying* ſhall be taught when I come to Treat of the uſe of the *Rule*.

You muſt note, that as I told you in *Smithing*, *Numb.* I. *fol.* 14, 15, 16. it was the office of the *courſe tooth'd File* to take off the prominent irregularities the *Hammer* made in the *Forging*, *&c.* and that you were not to *file* them more away than you need, ſo the ſame Caution is to be given you in the uſing of this *Fore Plain* in *Joynery*, for the reaſon there alledged in *Smithing*, whither, to avoid repetition, I refer you; only with this conſideration, that there *Iron* or *Steel* was the matter wrought upon, and there a *courſe File* the *Tool*; but now *Wood* is the matter, and a *Courſe* or *Fore-plain* the *Tool*.

§. 3. Of

## § 3 Of *ſetting* the *Iron.*

When you *ſet* the *Iron* of the *Fore-Plain*, conſider the *Stuff* you are to work upon, *viz.* whether it be *hard* or *ſoft*, or *Curling*, as *Joyners* call *Croſs-graind Stuff*: If it be *hard* or *curling*, you muſt not *ſet* the *Iron* very *rank*, becauſe a mans ſtrength will not cut deep into *hard wood*; and if it be not *hard wood*, but *curling* or *knotty*, and the *Iron rank ſet*, you may indeed work with it till you come to ſome *knot* or *curl*, but then you may either tear your *Stuff*, or break the edge of your *Iron*: therefore you may perceive a reaſon to *ſet* the *Iron fine* for *curling* and *knotty ſtuff*.

But if you ask me how *rank* your *Iron* ought to be ſet? I anſwer, If your wood be *ſoft* and your *Stuff free* and *frowy*, that is, evenly temper'd all the way, you may *ſet* the *Iron* to take a ſhaving off the thickneſs of an old coined ſhilling, but ſcarce thicker; whereas, if your *Stuff* be *hard*, or *curling*, or *knotty*, you ſhall ſcarce be able to take a ſhaving off the thickneſs of an old Groat: Therefore you muſt examine the temper of your *Stuff*, by eaſy tryals, how the *Plain* will work upon it, and *ſet* your Iron accordingly. And obſerve this as a General Rule, that the *Iron* of the *fore-Plain*, is for the firſt working with it to be *ſet* as *rank* as you can make good work with; and that for ſpeed ſake.

If your *Iron* be *ſet* too *rank*, knock with an *Hammer* upon the *Britch* of the *Stock*, and afterwards upon the *wedge*, for this knocking upon the *Britch*, if you knock hard enough 'twill raiſe the *Iron* a little, and *ſet* it *fine*; if you knock not hard enough, you muſt knock again, till the *Iron* do riſe, but if you

knock too hard, it will raiſe the *Iron* ſo much, that its edge will riſe above the *Sole* into the *Mouth* of the *Stock*, and conſequently not touch the *Stuff*: therefore you muſt knock ſoftly at firſt, till by tryals you find the *Iron* riſes to a convenient *fineneſs*. But as this knocking on the *Britch* raiſes the *Iron*, ſo it alſo raiſes and looſens the *wedge*: therefore (as aforeſaid) whenever you knock upon the *Britch*, you muſt alſo knock upon the *wedge*, to faſten the *Iron* again.

If you have raiſed the edge of the *Iron* too *fine*, you muſt knock ſoftly upon the head of the *Iron*, and then again upon the *wedge*, and this you may ſometimes do ſeveral times, till you fit your *Iron* to a convenient *fineneſs*.

When you have occaſion to take your *Iron* out of the *Stock* to *rub* it, that is to *whet* it, you may knock pretty ſmart blows upon the *Stock*, between the *Mouth* and the *Fore-end*, to looſen the *wedge*, and conſequently the *Iron*.

Theſe ways of *ſetting* are uſed to all other *Plains*, as well as *Fore-plains*.

In the uſing of this, and indeed all other *Plains*, you muſt begin at the hinder end of the *Stuff*, the Grain of the wood laying along the length of the *Bench*, and Plain forward till you come to the fore-end, unleſs the *Stuff* proves *Croſs-grain'd*, in any part of its length; for then you muſt turn your *Stuff* to Plain it the contrary way ſo far as it runs *Croſs-grain'd*. And in Plaining you muſt at once lean pretty hard upon the *Plain*, and alſo thruſt it very hard forwards, not letting the *Plain* totter to or from you-wards, till you have made a ſtroak the whole length of the *Stuff*. And this ſometimes if your *Stuff* be long, will require your making two or three

ſteps

ſteps forwards, ere you come to the fore-end of the *Stuff*: But if it do, you muſt come back, and begin again at the farther end, by the ſide of the laſt Plain'd, ſtroak, and ſo continue your ſeveral lays of Plaining, till the whole upſide of the *Stuff* be Plained.

And if the *Stuff* be broad you are to Plain upon, and it *warp* a little with the *Grain*, or be any ways crooked in the bredth, you muſt then turn the *Grain* athwart the *Work-Bench*, and Plain upon the *Croſs-Grain*. For, if your work be hollow in the middle, you muſt Plain both the Bearing ſides thinner, till they come to a *Try* with the middle. Then turn the other ſide of your work, and working ſtill *Croſs-grain'd*, work away the middle, till it come *Try* with the two ſides.

This way of *Croſs-Grain'd* working, is by Workmen called *Traverſing*.

Thus have you in general the uſe of all the other *Plains*: But the uſe of thoſe *Plains* that are deſigned for other particular purpoſes, I ſhall ſhew as they come in Order.

## § 4 Of the *Joynter*. B 2.

The *Joynter* is made ſomewhat longer than the *Fore-plain*, and hath its *Sole* perfectly ſtraight, from end to end. Its office is to follow the *Fore-plain*, and to *ſhoot* an edge perfectly ſtraight, and not only an edge, but alſo a Board of any thickneſs; eſpecially when a *Joynt* is to be *ſhot*. Therefore the Hand muſt be carried all along the whole length with an equal bearing weight, and ſo exactly even and upright to the edges of the Board, that neither ſide of the *Plain* encline either inward or outwards,

but

but that the whole breadth be exactly ſquare on both its ſides; ſuppoſing its ſides ſtraight: ſo will two edges of two boards, when thus *ſhot*, ly ſo exactly flat and ſquare upon one another, that light will not be diſcerned betwixt them. But yet it is counted a piece of good workmanſhip in a *Joyner*, to have the craft of bearing his hand ſo curiouſly even, the whole length of a long Board: and yet it is but a ſleight to thoſe Practice hath inur'd the Hand to. The *Joynter* is alſo uſed to *Try* Tables with, (large or ſmall) or other ſuch broad work; and then *Joyners* work as well upon the *Traverſe* with it as with the Grain of the wood, and alſo Angularly or Corner-wiſe, that they may be the more aſſur'd of the flatneſs of their work.

Its *Iron* muſt be *ſet* very *fine*, ſo fine, that when you wink with one Eye and ſet that end the ſtraight ſide of the *Iron* is next to the other Eye, there appear a little above an hairs bredth of the *edge* above the ſuperficies of the *ſole* of the *Plain*, and the length of the *edge* muſt ly perfectly ſtraight with the flat bredth of the *ſole* of the *Plain*: For the *Iron* being then well wedg'd up, and you working with the *Plain* thus *ſet*, have the greater aſſurance, that the *Iron* cannot run too deep into the *Stuff*, and conſequently you have the leſs danger that the *Joynt* is wrought out of ſtraight.

### § 5. The Uſe of the *Strike-block*.

The *Strike-Block* marked B 3. is a *Plain* ſhorter than the *Joynter*, having its *ſole* made exactly flat, and ſtraight, and is uſed for the *ſhooting* of a ſhort *Joynt*; becauſe it is more handy than the long *Joynter*. It is alſo uſed for the framing and fitting the

Joynts

Joynts of *Miters* and *Bevels*; but then it is uſed in a different manner from other *Plains*: For if the *Miter* and *Bevel* you are to fit be ſmall, you muſt hold it very ſteddy in your left hand, with the *Sole* of it upwards, and its fore-end towards your right hand: and you muſt hold your work in your right hand very ſteddy: Then apply the ſawn *Miter* or ſawn *Bevel* end of your *Stuff*, to the fore-end of the *Strike-Block*, and ſo thruſt it hard and upright forwards, till it paſs over the edge of the *Iron*, ſo ſhall the edge of the *Iron*, with ſeveral of theſe thruſts continued, cut or plain off your *ſtuff* the roughneſs that the *Teeth* of your *Saw* made: But if your work be ſo big that you cannot well weild it in your right hand, you muſt ſet the end of your work in the *Bench-ſcrew*, and Plain upon it with a *ſmoothing Plain*.

§ 6. *The Uſe of the* Smoothing Plain.

The *Smoothing Plain* marked B 4. muſt have its *Iron ſet* very *fine*, becauſe its Office is to ſmoothen the work from thoſe Irregularities, the *Fore-Plain* made.

§ 7. *The Uſe of the* Rabbet Plain.

The *Rabbet-Plain* marked B 5. is to cut part of the upper edge of a Board or other *Stuff* ſtraight, that is, ſquare down into the Board, that the edge of another Board alſo cut down in the ſame manner, may fit and joyn into the Square of the firſt board thus cut away: And when two Boards are thus *lapped* on the edges over one another, this *lapping* over is called *Rabbetting*.

The *Rabbet Plain* is alſo ſometimes uſed to ſtrike

a *Facia* in a peice of *Molding*; as ſhall be ſhewed in its proper place.

The ſides of the *Iron* are not incloſed in the *Stock* of this *Plain*, as the foregoing *Plains* are, but the *Iron* is full as broad as the *ſtock* is thick, that the very angles of the edge of the *Iron* may not be born off the *ſtuff*, to hinder the ſtraight and ſquare cutting it down: nor doth it deliver its ſhaving at a *Mouth* on the top of the *Stock* as the other *Plains* do: But it hath its *Mouth* on the ſides of the *Plain*, and delivers its ſhavings there. Its *Iron* is commonly about an Inch broad.

### § 8. *The Uſe of the* Plow.

The *Plow* marked B 6. is a narrow *Rabbet-Plain* with ſome additions to it: *viz.* two ſquare *Staves*, marked *a a* (yet ſome of them have the upper edges of them rounded off for the better complyance with the Hand) Theſe *Staves* are let ſtiff through two ſquare Morteſſes in the *ſtock*, marked *b b*. They are about ſeven or eight Inches long, and ſtand ſtraight and ſquare on the farther ſide of the *ſtock*; and theſe two *ſtaves* have ſholders on the higher ſide of the *ſtock* reaching down to the wooden *ſole* of the *Plain* (for there is alſo an *Iron ſole* belonging to the *Plow*) To the bottom of theſe two Sholders is Rivetted with Iron Rivets a *Fence* (as workmen call it) which comes cloſe under the *Wooden ſole*, and its depth reaches below the *Iron ſole* about half an Inch: Becauſe the *Iron* of the *Plow* is very narrow, and the ſides of it towards the bottom are not to be incloſed in the *ſtock*, for the ſame reaſon that was given in the *Rabbet-plain*; therefore upon the *ſtock* is let in and ſtrongly nailed an Iron Plate of the thickneſs of the *Plow Iron*, for wood of

of that bredth will not be ſtrong enough to endure the force the lower end of the *Plow Iron* is put to: This *Iron Plate* is almoſt of the ſame thickneſs that the bredth of a *Plow Iron* is. Joyners have ſeveral *Plows* for ſeveral widths of *Grooves*.

The Office of the *Plow* is to *plow* a narrow ſquare *Groove* on the edge of a Board; which is thus perform'd. The Board is ſet an edge with one end in the *Bench ſcrew*, and its other edge upon a *Pin* or *Pins* put into a *Hole* or *Holes* in the *Leg* or *Legs* of the *Bench*, ſuch an *Hole* or *Holes* as will moſt conveniently for height fit the bredth of the Board; Then the *Fence* of the *Plow* is ſet to that diſtance off the *Iron Plate* of the *Plow* that you intend the *Groove* ſhall ly off the edge of the Board: As if you would have the *Groove* ly half an Inch off the Board, then the two *ſtaves* muſt with the *Mallet* be knocked through the Morteſſes in the *ſtock* till the *Fence* ſtands half an Inch off the *Iron Plate*: And if the *ſtaves* are fitted ſtiff enough in the Morteſs of the *ſtock*, it will keep at that diſtance whiles you *Plow* the *Groove*: For the *Fence* (lying lower than the *Iron* of the *Plain*) when you ſet the *Iron* of the *Plow* upon the edge of the Board, will ly flat againſt the farther edge of the Board, and ſo keep the *Iron* of the *Plow* all the length of the Board at the ſame diſtance from the edge of the Board that the *Iron* of the *Plow* hath from the *Fence*. Therefore your *Plow* being thus fitted, *Plow* the *Groove* as you work with other *Plains*, only as you layd hold on the *ſtock* of other *Plains* when you uſe them, now you muſt lay hold of the two *ſtaves* and their *ſholders*, and ſo thruſt your *Plow* forwards, till your *Groove* be made to your depth.

If the *Staves* go not ſtiff enough in the Morteſs of the *ſtock*, you muſt ſtiffen them by knocking a little wooden wedge between the *ſtaves* and their Morteſſes.

## § 9. *Of* Molding Plains.

There are ſeveral other *Plains* in uſe among Joyners, called *Molding-plains*; as, the *Round*, the *Hollow*, the *Ogee*, the *Snipes-Bill*, the *Rabbet-plain*, the *Grooving-plain*, &c. And of theſe they have ſeveral ſorts, *viz.* from half a quarter of an Inch, to an Inch and a half. They are uſed as other *Plains* are.

In the Plaining of *ſtuff*, you muſt uſe *Plains* whoſe *Irons* have different Mountings; and that according to the hardneſs or ſoftneſs of the Wood you are to work upon: For if the wood be hard, the *Iron* muſt ſtand more upright than it need do if the wood be ſoft: For ſoft wood, as *Deal*, *Pear-tree*, *Maple*, &c. The *Iron* is ſet to make an Angle of 45 degrees with the *Sole* of the *Plain*: But if it be very hard wood you are to Plain upon, as *Box*, *Ebony*, *Lignum Vitæ*, &c. It is ſet to 80 degrees, and ſometimes quite upright: ſo that theſe hard woods are indeed more properly ſaid to be Scraped, than Plained.

But before you come to uſe your *Plains*, you muſt know how to grind and whet them, for they are not ſo fitted when they are bought, but every workman accomodates them to his purpoſe, as if it be an hard wood he is to work on, he grinds his *Baſil* to a more obtuſe Angle than he would do for ſoft wood.

The *Baſil* or Angle an Iron is ground to, to work on ſoft-wood is about 12 degrees, and for hard wood about

about 18 or 20 degrees. Where note; that the more accute or thinner the *Basil* is the better and ſmoother the *Iron* cuts, and the more obtuſe and thicker, the ſtronger the edge is to work upon hard work.

§. 10. *Of Grinding and Whetting the* Iron, *and other* Edge-Tools.

When you grind your *Iron*, place your two thumbs under the *Iron*, and your Fingers of both hands upon the *Iron*, and ſo clap down your *Iron* to the ſtone, holding it to that Angle with the *Stone* you intend the *Basil* ſhall have: keep the *Iron* in this poſture without either mounting or ſinking its ends all the while the *Stone* is turning about; And when you lift the *Iron* off the *Stone*, to ſee if it be ground to your mind; if it be not, you muſt be ſure you place the *Iron* again in the ſame Poſition on the *Stone* it had before: for elſe you will make a double *Basil* on your *Iron*: But if it be true ſet on the *Stone* and ſteddily kept to that Poſition your *Basil* will be *Hollow*, and the ſmaller your *Grindſtone* is, the hollower it will be. You may know when it is well Ground, by the evenneſs and entireneſs of the edge all the way.

Having ground your *Iron*, you muſt ſmoothen the edge finer with a good fine *Whet-ſtone*. Thus, hold the edge of your *Iron* upwards in your left hand and your *Whet-ſtone* in your right, and having firſt ſpit upon your Stone to wet it, apply it to the *Basil* of your *Iron*, in ſuch a Poſition that it may bear upon the whole bredth of the *Basil*; and ſo working the *Stone* over the *Basil* you will quickly wear the courſer grating of the *Grind ſtone* off the

edge on that ſide: Then turn the flat ſide of the *Iron*, and apply the *Stone* flat to it, till you have worn off the courſe gratings of the *Grind ſtone*, on that ſide too.

Joyners often grind their *Irons* upon a flat *Grind-ſtone* alſo: And then they hold the *Iron* alſo in their hands in the ſame poſture as if it were to be ground on the *Round Grindſtone*: yet then inſtead of keeping the *Iron* on one place of the *Stone*, they thruſt it hard ſtraight forwards, almoſt the length of the *Stone*, and draw it lightlier ſtraight back again, keeping it all the while at the ſame Angle with the ſuperficies of the *Stone*; and then ſmoothen its edge with the *Whet-ſtone*, as if it had beed ground upon the round *Grind ſtone*. And this they do ſo often, till they have rubbed the hollowneſs of the *Baſil* to a flat, and then they grind it again upon the round *Grind ſtone*.

This Order and Manner of *Setting*, *Grinding* and *Smoothing* a *Baſil* and *Edge*, is alſo uſed in all other *Edge-Tools Joyners* uſe.

## § 10. *of* Chiſſels of ſeveral ſorts, *And firſt of* Formers.

*Formers* marked C 1, C 3 are of ſeveral ſizes. They are called *Formers* becauſe they are uſed before the *Paring Chiſſel*, even as the *Fore-Plain* is uſed before the *Smoothing-Plain*. The *Stuff* you are to work upon being firſt ſcribed (as I ſhall ſhew in its proper place) you muſt ſet the edge of the *Former*, a little without the ſcribed ſtroak, with its *Baſil* outwards, that it may break and ſholder off the Chips from your work as the edge cuts it. And you muſt bear the *Helve* of the *Former* a little inwards

wards over the *Stuff*, that the *Former* do not at firſt cut ſtraight down, but a little outwards: For, ſhould you venter to cut ſtraight down at the firſt, you might with a negligent or unlukcly knock with the *Mallet* drive the edge of the *Former* under the work, and ſo cut before you are aware more off the under ſide than the upper ſide of your work, and ſo (perchance) ſpoil it. Therefore you may make ſeveral cuttings, to cut it ſtraight down by little and little, till your work is made ready for the *Paring Chiſſel.* When it is uſed the *Helve* of it is knockt upon with a *Mallet*, to drive the edge into the *Stuff.*

## § 11. *Of the* Paring Chiſſel.

The *Paring Chiſſel* C 2. muſt have a very fine and ſmooth edge: Its office is to follow the *Former*, and to *pare* off and *ſmoothen* the irregularities the *Former* made.

It is not knockt upon with the *Mallet*, but the Blade is claſped upon the outſide of the hindermoſt joynts of the four and little fingers, by the clutched inſide of the middle and third fingers of the right hand, and ſo its edge being ſet upon the *ſcribed line*, and the top of the *Helve* placed againſt the hollow of the inſide of the right ſholder, with preſſing the ſholder hard upon the *Helve*, the edge cuts and pares away the irregularrities.

This way of handling may ſeem a prepoſterous poſture to mannage an Iron Tool in, and yet the reaſon of the Original contriver of this poſture is to be approved; For, ſhould workmen hold the *Blade* of the *ParingChiſſel* in their whole hand, they muſt either hold their hand pretty near the *Helve* where

they

they cannot well mannage the *Tool*, or they muſt hold it pretty neer the edge, where the outſide of the fingers will hide the *ſcribed line* they are to *Pare* in. But this poſture all workmen are at firſt taught, and Practice doth ſo inure them to it, that if they would they could not well leave it.

### §. 12. *of the* Skew-Former.

The *Skew-Former* marked C 4 is ſeldom uſed by Joyners, but for cleanſing accute angles, with its accute Angle on its edge, where the *Angles* of other *Cheſſels* will not ſo well come.

### § 13. *of the* Morteſs Chiſſel.

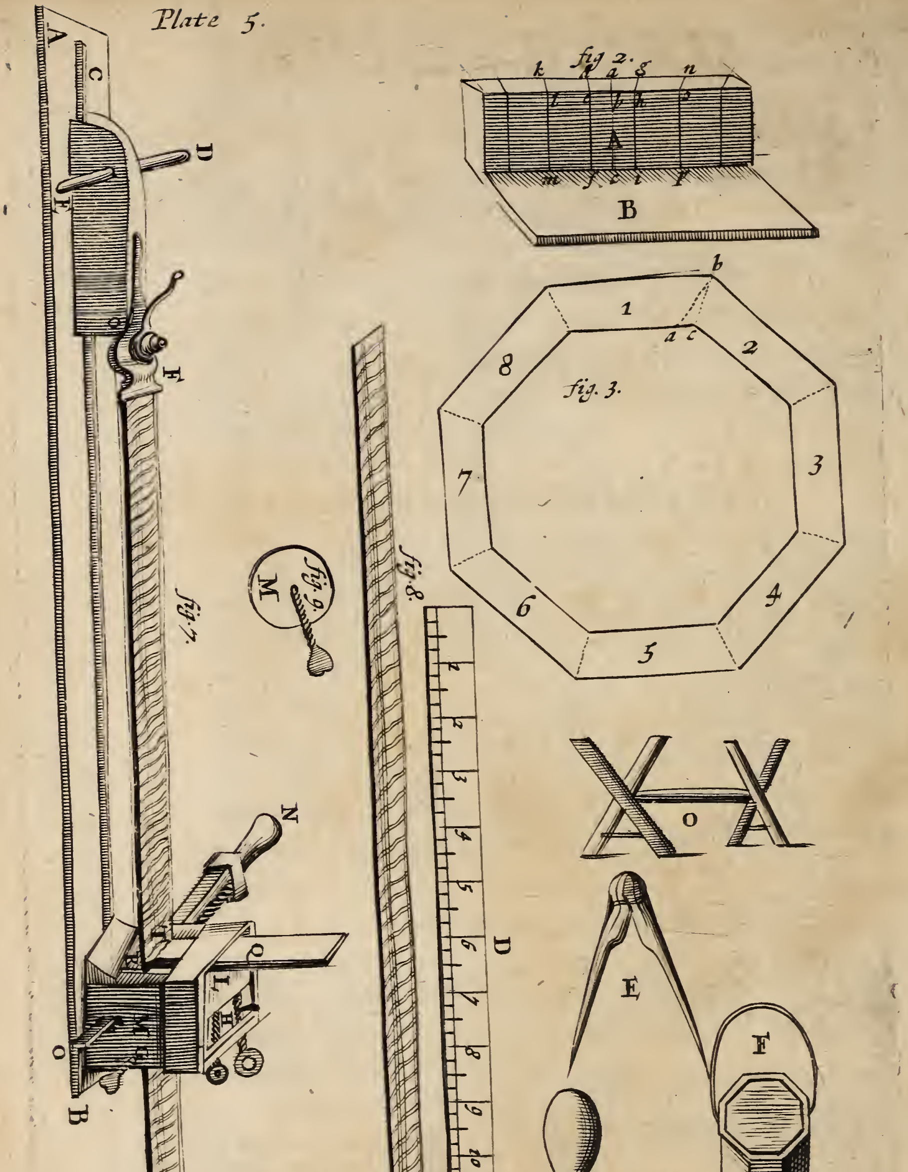
The *Morteſs Chiſſel* marked C 5. is a narrow *Chiſſel* but hath its *Blade* much thicker, and conſequenly ſtronger (that it may endure the heavier blows with the *Mallet*) than other *Chiſſels* have, ſo that in grinding it to an edge it is ground to a very broad *Baſil*, as you may ſee in the Figure. Its Office is to cut deep ſquare holes called *Morteſſes* in a peice of wood. Joyners uſe them of ſeveral Bredths according as the Bredths of their *Morteſſes* may require.

### § 14. *of the* Gouge.

The *Gouge* marked C 6. is a *Chiſſel* having a round edge, for the cutting ſuch wood as is to be Rounded or Hollowed.

Theſe ſeveral ſorts of *Chiſſels* Joyners have of ſeveral ſizes, that they may be accomodated to do ſeveral ſizes of work.

Plate 5.



# MECHANICK EXERCISES,

OR,

The Doctrine of

# Handy-works.

*From* May *the* 1. *to* June *the* 1. 1678. *And is intended to be Monthly continued.*

By *Joseph Moxon* Hydrographer to the King's most Excellent Majesty.

*LONDON,*
Printed for *Joseph Moxon*, at the Sign of *Atlas* on *Ludgate Hill.* 1678.

# MECHANICK EXERCISES.
OR,
# The Doctrine of *Handy-works*.

## Continued in the Art of *Joynery*.

### § 15. *Of the* Square, *and its Use*.

THE *Square*, marked D, is two adjunct Sides of a Geometrical Square. *a* The *Handle*, *b* The *Tongue*, *c* The *Outer Square*, *d* The *Inner Square*. For Joyners use it is made of two pieces of wood, the one about an Inch thick and the other about a quarter of an Inch thick: These two pieces are severally shot exactly straight, and have each of their Sides parallel to each of their own Sides. The thick Piece (called the Handle) hath a Mortess in it, as long within a quarter of an Inch as the thin piece (called the Tongue) is broad, and stifly so wide as to contain the thickness of the Tongue. The Tongue is fastned into the Mortess of the Handle with Glew and wooden Pins, so as the two outer sides (and then consequently the two inner sides) may stand at right angles with one another.

The Reason why the Handle is so much thicker than the Tongue, is because the Handle should on either side become a Fence to the Tongue. And the reason why the Tongue hath not its whole bredth let into the end of the Handle is, because they may with less care strike a line by the side of

a thin than a thick piece: For if instead of holding the hand upright when they strike a line, they should hold it never so little inwards, the shank of a Pricker falling against the top edge of the Handle would throw the Point of a Pricker farther out than a thin piece would: to avoid which Inconvenience the Tongue is left about half an Inch out of end of the Handle.

Another Reason is, That if with often striking the Pricker against the Tongue it becomes ragged, or uneven, they can with less trouble plain it again when the stuff is all the way of an equal strength, than they can if cross-graind shoulders be added to any part of it.

Its use is for the striking of lines square either to other lines or to straight sides, and to try the squareness of their work by; As if they would strike a line square to a side they have already shot; They apply the inside of the Handle close to the side shot, and lay the Tongue flat upon the work, then by the outerside of the Tongue they draw with a Pricker a straight line. This is called *Striking or drawing of a Square.* Or, if they would Try the squareness of a Piece of stuff shot on two adjoyning sides, they apply the insides of the Handle and Tongue to the outsides of the stuff, and if the outsides of the stuff do all the way agree in line with the insides of the Square, It is true Square. Or if they would try the inward squareness of work, they apply the two outsides of the Square to the insides of the work.

### § 16. *The manner of* Plaining *and* Trying *a piece of Stuff square.*

We will take for Exmple, a Piece of Stuff called

led a Quarter, which is commonly two Inches thick, four Inches broad, and ſeven Foot long. To plain this ſquare, Lay one of its broad ſides upon the Bench, with one of its ends ſhov'd pretty hard into the Teeth of the Bench-hook, that it may ly the ſteddyer. Then with the Fore-Plain as you were taught §2. *Numb.* 4. Plain off the roughneſs the Saw made at the Pit, and work that ſide of the Quarter as ſtraight in its length and breadth as you can with the Fore-Plain; which you may give a pretty good gueſs at, if the edge of the Iron have born all the way upon the work, yet you may try by taking up your work, and applying one end of it to one Ey while you wink with the other, and obſerve if any Hollow or Dawks be in the length; if not, you may conclude it pretty true: For the work thus held, the Ey will diſcern pretty nearly. Or, for more certainty you may apply the edge of the two Foot Rule, or rather a Rule ſhot the full length of the Quarter to your work, and if it agree all the way with the Rule, you may conclude it is ſtraight in length. But if you finde it not ſtraight, you muſt ſtill with the Fore Plain work off thoſe Riſings that bear the edge of the Rule off any part of the Stuff: Then try if the Bredth be pretty ſtraight, if it be (the Dawks the roughneſs the Fore Plain made excepted) the firſt office of the Fore Plain is perform'd: If it be not, you muſt ſtraighten the Bredth as you did the Length.

But though this Quarter be thus plained ſtraight in length and breadth, yet becauſe the Iron of the Fore Plain for its firſt working the ſtuff is ſet Rank, and therefore makes great Dawks in the ſtuff, you muſt ſet the Iron of your Fore plain finer, as you were

taught §3. *Numb.* 4. and with it then work down even almost to the bottom of those Dawks: then try it again, as before, and if you find it Try all the way, you may with the Joynter or Smoothing Plain, but rather with the Joynter, go over it again, to work out the irregularities of the fine Fore Plain: For the Iron of the Fore Plain being ground to a Rising in the middle, as has been shewed § 2. *Numb.* 4. though it be very fine set, will yet leave some dawks in the Stuff for the Joynter or smoothing Plain to work out. Thus the first side of the Quarter will be finished.

Having thus Tryed one side of the Quarter straight and flat, Apply the in-side of the Handle to it, and if one of the adjoyning sides of the Quarter comply also with the in-side of the Tongue all the way, you need only smooth that adjoyning side: But if it do not so comply, that is, if it be not square to the first side, which you will know by the riding of the in-side of the Tongue upon one of the edges, or some other part between the edges, you must with the Fore-Plain Rank-set plain away that stuff which bears off the inside of the Tongue from complying all the way with it. But if the risings be great, you may for quickness hew away the Risings with the Hatchet: but then you must have a care you let not the edge of your Hatchet cut too deep into the stuff, lest you either spoil your stuff by making it unsizeable, if it be already small enough; or if it have substance enough, make your self more labour to get out those Hatchet stroaks with the Plain than you need. Then take off the roughness the Hatchet made with the Fore-Plain Rank-set, then fine set, and last of all with the Joyn-

ter or ſmoothing Plain : ſo is the ſecond ſide alſo finiſhed.

To work the third ſide, ſet the Oval of the Gage exactly to that width from the Gage that you intend the Bredth of the Quarter (when wrought) ſhall have, which in this our Example is four Inches, but will be ſomewhat leſs, becauſe working it true will deminiſh the ſtuff: Therefore ſliding the Oval on the Staff, meaſure on your Inch Rule ſo much leſs than four Inches as you think your ſtuff deminiſhes in working: Meaſure, I ſay, between the Oval and the Tooth, your ſize; If at the firſt proffer your Oval ſtand too far from the Tooth,Hold the Oval in your hand and knock the Tooth end of your ſtaff upon the work Bench till it ſtand near enough: If the Oval ſtand too near knock the other end of the Staff upon the Work-Bench till it be fit. Then apply the flat of the Oval to the ſecond wrought ſide of your Stuff, ſo as the Tooth may reach athwart the bredth of the ſtuff upon the firſt ſide, and keeping the Oval cloſe againſt the ſecond ſide, preſs the Tooth ſo hard down that by drawing the Gage in this Poſture all along the length of the Quarter, the Tooth may ſtrike a line. In like manner upon the ſide oppoſite to the firſt, viz. the fourth ſide, Gage another line oppoſite to the firſt gaged line, and work your ſtuff down to thoſe two Gaged lines on the third ſide,either with Plaining alone,or with Hewing and afterwards Plaining, as you were taught to Work the ſecond ſide.

To Work the fourth ſide ſet the Tooth of the Gage to its exact diſtance from the Oval, viz. two Inches wanting ſo much as you think the ſtuff diminiſh'd.

miniſht in working, and apply the flat of the Oval to each ſide of the firſt ſide, and Gage as before two lines, one on the ſecond, the other on the third wrought ſide. Work your ſtuff then down on the fourth ſide to theſe two Gage lines, either with Plaining alone, or with Hewing and afterwards Plaining, as you were taught to work the ſecond ſide.

### § 17. *To* Frame *two* Quarters *Square, into one another.*

You muſt take care in Morteſſing and Tennanting, that as near as you can you equallize the ſtrength of the ſides of the Morteſs to the ſtrength of the Tennant. I do not mean that the ſtuff ſhould be of an equal Subſtance, for that is not equallizing ſtrength: But the equallizing ſtrength muſt be conſidered with reſpect to the Quality, Poſition and Subſtance of the Stuff. As if you were to make a Tennant upon a piece of Fur, and a Morteſs to receive it in a piece of Oak, and the Fur and Oak have both the ſame ſize. The Tennant therefore made upon this piece of Fur muſt be conſiderably bigger than a Tennant need be made of Oak, becauſe Fur is much a weaker wood than Oak, and therefore ought to have a greater Subſtance to equallize the ſtrength of Oak. And for Poſition, the ſhorter the ſtuff that the Tennant is made on, the leſs Violence the Tennant is ſubject to. Beſides it is eaſier to ſplit wood with the grain, than to break wood croſs the grain; and therefore the ſame wood when poſited as a Tennant is ſtronger than the ſame wood of the ſame ſize when poſited as a Morteſs: for the injury a Morteſs is ſubject to is ſplitting with the grain of the wood, which without good care it will often

do

do in working: but the force that muſt injure a Tennant muſt offend it croſs the grain of the wood, in which poſition it will beſt indure violence.

When two pieces of wood of the ſame quality and ſubſtance (as in this our Example) are elected to make on the one a Tennant, and in the other a Morteſs. If you make the Morteſs too wide, the ſides of the Morteſs will be weaker than the Tennant; or, if too narrow, the Tennant that muſt fit the Morteſs will be weaker than the ſides that contain the Morteſs: And if one be weaker than the other the weakeſt will give way to the ſtrongeſt when an equal violence is offer'd to both. Therefore you may ſee a neceſſity of equallizing the ſtrength of one to the other, as near as you can. But becauſe no Rule is extant to do it by, nor can (for many conſiderations I think) be made, therefore this equallizing of ſtrength muſt be referred to the Judgment of the Operator. Now to the work.

The Morteſs to be made is in a Quarter four Inches broad. In this caſe workmen make the Morteſs an Inch wide, ſo that an Inch and an half ſtuff remains on either ſide it. Therefore your ſtuff being ſquar'd as was taught in the laſt Section, Set the Oval of the Gage an Inch and an half off the Tooth, and gage with it on either ſide your ſtuff a ſtraight line at that diſtance from the end you intend the Morteſs ſhall be: then open your Compaſſes to two Inches, and prick off that diſtance in one of the lines, for the length of the Morteſs: then lay the inſide the Handle of the Square to one ſide of the ſtuff, and upon both the pricks ſucceſſively, and with your Pricker draw ſtraight lines through them by the ſide of the Tongue, ſo ſhall the bounds of your Morteſs be

ſtruck

ſtruck out on the Quarter. If your Morteſs go through the Quarter,draw the ſame lines on the oppoſite ſide of the Quarter, thus, Turn the Quarter or its edge,and apply the inſide of the Handle of the Square to the ends of the former drawn lines,and by the ſide of the Tongue draw two lines on the edge of the Quarter, then turn the Quarter again with its other broad ſide upwards, and apply the inſide of the Handle of the Square to the ends of the laſt lines drawn on the edge, and by the ſide of the Tongue draw two lines on this broad ſide alſo. Theſe two lines(if your quarter was truly ſquar'd) ſhall be exactly oppoſite to the two lines drawn on the firſt broad ſide of the quarter, for the length of the Morteſs: And for the width of the Morteſs Gage this ſide alſo,as you did the firſt: then for the Tennant,Gage on that end of the Quarter you intend the Tennant ſhall be made,the ſame lines you did for the Morteſs. And becauſe the Quarter is two Inches thick, prick from the end two Inches,and applying the inſide of the Handle of the Square to the ſide of the Quarter, and the Tongue to that Prick, draw by the ſide of the Tongue a line through that ſide the Quarter: then turn the other ſides of the Quarter ſucceſſively, and draw lines athwart each ſide the Quarter,as you were taught to draw the oppoſite lines for the Morteſs.

Then place the edge of the Inch Morteſs Chiſſel with its Baſil from you, and the Helve bearing a little towards you, within one half quarter of an Inch of one end of the ſtruck Morteſs, and with your Mallet knock hard upon it, till you find the Baſil of the Chiſſel will no longer force the chips out of the Morteſs: then remove the Chiſſel to the other end

of

of the Mortefs, and work as with the firft end, till the Chips will void no longer: Then work away the Stuff between the two Ends, and begin again at one of the ends, and then at the other, and work deeper into the Mortefs, then again between both; and fo work deeper by degrees, till you have wrought the Mortefs through, or (if not through) to the intended depth: then with the Mortefs Chiffel work nearer the drawn lines at the ends of the Mortefs (for before you were directed to work but within half a quarter of an Inch of the drawn lines,) by laying light blows on it, till you have made it fit to pare fmooth with a narrow Paring Chiffel, and then pare the ends, as you were taught to work with the Paring Chiffel: then with the broad Paring Chiffel, pare the fides of the Mortefs juft to the ftruck lines; fo is the Mortefs finifhed.

To work the Tennant lay the other Quarter on edge upon your Work Bench, and faften it with the Holdfaft, as you were taught Sect.I. Then with the Tennant Saw Saw a little without the ftruck line towards the end: you muft not Saw juft upon the ftruck line, becaufe the Saw cuts rough: Befides, you muft leave fome ftuff to pare away fmooth to the ftruck line, that the *Stile* (that is, the upright Quarter) may make a clofe Joynt with the *Rail* (that is) the lower Quarter: Saw therefore right down with the Tennant Saw, juft almoft to the gaged lines for the thicknefs of the Tennant, and have a care to keep the Blade of the Saw exactly upright. Then turn the oppofite fide of the Quarter upwards, and work as you were taught to work the firft fide.

Then with the paring Chiffel, pare the work

O clofe

close to the gaged lines for the Tennant. Then try how it fits the Mortess: If it be not pared enough away, you must Pare it where it Bears, that is, sticks. But if you should chance to have made it too little, you have spoiled your work: Therefore you may see how necessary it is not to make the Mortess too wide at first, or the Tennant too narrow.

Then with the Piercer pierce two holes through the sides or cheeks of the Mortess, about half an Inch off either end one. Then knock the Tennant stiff into the Mortess, and set it upright by applying the angle of the outer square to the angle the two Quarters make, and with your Pricker prick round about the insides of the Pierced holes upon the Tennant. Then take the Tennant out again, and Pierce two holes with the same Bit about the thickness of a shilling above the Pricked holes on the Tennant, that is, nearer the sholder of the Tennant, that the Pins you are to drive in may draw the sholder of the Tennant the closer to the flat side of the Quarter the Mortess is made in. Then with the Paring Chissel make two Pins somewhat Tapering, full big enough, and setting the two Quarters again square as before, Drive the Pins stiff into the Pierced holes.

If you make another Square as you did this; and make also a Tennant on each un-Tennanted end of the Stiles, and another Mortess on the top and bottom Rails, you may put them together and make square Frame of them.

## § 18. *Of the* Miter Square. *And its Use.*

The Miter square marked E hath (as the Square) an Handle marked *a* one Inch thick, and three Inch-

es

es broad, and a Tongue marked *b* of about the same bredth: the Handle and the Tongue (as the Square) have both their sides parallel to their own sides. The Handle (as the square) hath in the middle of its narrowest side a Mortess in it, of an equal depth the whole length of the Handle: Into this Mortess is fitted one end of the Tongue, but the end of the Handle is first Bereld off to make an Angle of 45 Degrees with its inside. This Tongue is (as the square) Pind and Glewed into the Mortess of the Handle.

It is used for striking a Miter line, as the Square is to strike a square line, By applying the Inside of the Handle to the outside of the Quarter or Batten, you are to work upon: and then by striking a line by the side of the Tongue: For that line shall be a Miter line. And if upon two Battens you strike two such lines, and Saw and Pare them just off in the lines, when the flatts of those two sawn ends are applyed to one another, the out and inside of the Battens will form themselves into the Figure of a Square.

Thus Picture Frames and looking Glass-frames are commonly made, as by a more full Example you may see in the next Section.

## § 19. *Of the* Bevil.

As the Square is made to strike an Angle of 90 Degrees, and the Miter an Angle of 45 degrees, so the Bevil (marked F) having its Tongue movable upon a Center may be set to strike angles of any greater or lesser numbers of Degrees, according as you open the Tongue wider from, or shut it closer to the Handle. It is used as the Square, and the Miter, and will perform the Offices of them both, though it be not purposely made for either; but for

the ſtriking ſuch Bevil lines as one part of your work muſt be cut away to,to make it joyn with anther part of your work: for Example.

We will propoſe to make a Frame for a Picture, Looking Glaſs, &c. containing eight ſtraight ſides; You may quickly perceive that all the ends of theſe eight ſides muſt be cut to Bevils, and what Bevils they muſt be, you will,find if you deſcribe upon a ſmooth flat Board a Circle of any bigneſs, but the larger the beter: Devide this Circle into eight equal parts,and from every point draw a line to the Center: Draw alſo ſtraight lines from every point to its next point: Then lay the Inſide of the Handle of your Bevil exactly upon any one of theſe ſtraight lines, ſo as the angle made by the inſide of the Handle and the inſide of the Tongue lye exactly at the very angle made by this ſtraight line,and theSemi-Diametral line proceeding from the Center,and move the Tongue nearer or farther off the Handle till the inſide of the Tongue and the inſide of the Handle ly exactly upon thoſe two lines,So ſhall your Bevil be ſet.

Then having fitted your Peeces to your Scantling, Stick your Pricker as neer the outward Corner of your Peeces as your ſtuff will bear,and apply the inſide of your handle alſo to the outer ſides of your Pieces,and ſo as the inſide of the Tongue may be drawn home to the Pricker. For then lines drawn on thoſe Peeces by the inſide of the Tongue ſhall be the lines the Pieces muſt be cut in to make theſe eight Pieces joyn evenly together by the ſides of each others Bevil: then with the Strike-block ſmooth the ends of the Bevils, as you were taught in the Section of the Strike-Block.

If you have a Board on the Back-ſide of this Frame

Frame,you may Glew the backſides of theſe Peeces Peece by Peece to the Board; but firſt you muſt fit them to an exact complyance of every Bevil with its Match, and when they are ſo fitted, drive two Nails cloſe to the outſide of every Peece, but drive not the Nails deep into the Board, becauſe when the Frame is ſet and Glewed, or othewiſe faſtned, you muſt draw the Nails out again, For theſe Nails are only intended to ſerve for Fences to ſet and fit each peece into its proper place, before the whole Frame is faſtned together. And ſhould you not thus Fence them, though by your Eye you might judge you fitted the Bevils exactly, yet one Peece being never ſo little out of its due poſition would drive the next peece more out, and that the next, till at the laſt, the laſt Peece would not joyn, but either be too ſhort, or too long, or ſtand too much out,or in, or elſe too open, or too cloſe on the out or inſide.

But if you have no Board on the backſide, you muſt when you Saw the Bevelling angles upon the ſquare ends of Pieces not ſawn quite through the depth of one end of every peece,but about half way through the depth or thickneſs,and then with your Chiſſel either ſplit or elſe pare the upper ſide of the ſquare end flat away to the Bevil, and ſo leave part of the ſquare end of your piece to lap under the peece is joyned to. For Example:

In fig.3 Plate 5. *a b* is the ſquare end of the peece, and *b c* is the Bevil you work the Peece to. Therefore you muſt work away ſo much of the thickneſs of the ſquare end as is comprehended between *a* and *c*, ſo that you will ſee the Triangle *a b c* is to be wrought away half way down the thickneſs

of the ſtuff,and ſo will the Triangle *a b c* be left for the other half thickneſs of the ſtuff. But that end of the piece mark'd 1,which joyns to the Peece mark'd 2,muſt upon its Bevil ſtroak be ſawn quite off, and its underſide muſt have the ſame Triangle wrought into it,juſt ſo fit as to receive the Triangle in Peece 2,and juſt ſo deep as that when theTriangle on Peece 2 is fitted into the Triangle in Peece 1 the Superficies of both the Peeces may be even with one another. And thus you may lap the ends of every Peece into one another.

Theſe Triangles at the ends of the Peeces you may Glew into one another,but if you think Glewing alone not ſtrong enough, you may Pierce an hole neer the inner edge of the Frame, becauſe the Triangle hath there moſt ſubſtance of ſtuff; and afterwards Pin it, as you are taught to Pin the Rail and Stile together in Sect. 17.

This way of Lapping over is ſometimes uſed alſo for ſquare Miters,or other Angular Frames.

## §. 20. *Of the* Miter Box.

There is another way uſed by Joyners that make many Frames to ſave themſelves the labour of Drawing or ſtriking out of Squares, Miters, and ſeveral Bevils upon their ſtuff : And this is with a Tool called a *Miter Box*, deſcribed in Plate 5. fig.2. It is compoſed of two Peeces of Wood, of an Inch thick each, as A the upright Peece, B the Bottom Piece. The Upright piece is nailed upright, faſt upon the Bottom Piece. And this Upright Peece hath on its upper ſide the Miter Lines ſtruck with the Miter ſquare,as *d e*, on the left hand, and *g h* on the right hand : on theſe two Miter lines the edge of

of the Saw is ſet, and a kerf made ſtraight down the upright peece, as from *d e* on the left hand to *f*, and from *g h* on the right hand to *i*. In like manner any other Bevil is ſtruck upon the upper ſide of the upright peece with the Bevil, as *k l* on the left hand, and *n o* on the right. On theſe two Bevil lines the edge of the Saw is ſet, and a kerf made ſtraight down the upright peece, as from *k* to *l m*, and from *g h* to *i*. You may make as many Bevils as you pleaſe on the upright peece,of the Miter Box; Bevils to joyn Frames of either five, ſix, ſeven,eight ſides &c. and the manner to make them to any number of ſides was in part taught in the laſt Section. For as there you were directed to devide the Circle into eight equal parts,becauſe eight was the number of ſides, we propoſed to make that Frame conſiſt of; So, if for any number of ſides you devide the Circle into the ſame equal parts,and work as you were there directed,you may find what Bevil the Peeces muſt have that make a Frame that conſiſts of any number of ſides.

So alſo for Sawing of any Batten, or other ſmall pieces ſquare;Strike at the point *a* on the upper ſide of the upright Peece a line ſtraight athwart it, to *b*, and Saw ſtraight down the upper peece, to *c*.

The manner how theſe kerfs are Sawn ſtraight down with greateſt certainty is, thus, Apply the inſide of the Handle of the ſquare to the upperſide of the upright piece, ſo as the Tongue lye cloſe to that end of the Miter, Bevil, or ſquare line ſtruck through the upper ſide of the Miter Box, and with the Picker ſtrike a line cloſe by the ſide of the Tongue through that ſide of the upright Peece; Turn the Tongue to the other ſide the upright

Peece

Peece and apply the inside of the Handle of the square to the other end of the Miter, Bevil, or square line, and with the Pricker strike also a line close by the side of the Tongue through that side the upright Peece. These two lines struck on either side of the upright peece shall be a line on each side in which the edge of the Saw must run, to saw it straight down.

§ 21. *Of the* Gage.

The *Gage* mark'd G (in *Plate* 4.) The *Oval b* is fitted stiff upon the *Staff c*, that it may be set nearer or farther from the *Tooth a*. Its Office is to *Gage* a line parallel to any straight side. It is used for *Gaging* Tennants, and for *Gaging* Stuff to an equal thickness.

When you use it, you must set rhe *Oval* to the intended Distance from the *Tooth:* If the Oval stand too near the Tooth, Hold the Oval in your right hand, and knock the hinder end of the Staff upon the work bench, till it remove to its just distance from the Tooth: If it stand too farr off the Tooth, knock the fore end of the Staff (viz. the Tooth end) till it remove to its just distance from the Tooth: If the Oval slide not stiff enough upon the Staff, you may stiffen it by striking a wooden wedge between the Mortess and the Staff: So may you apply the side of the Oval next the Tooth, to the side of any Table or any other straight side, with the Tooth Gage a line parallel (or of equal distance) all the way from that side.

§ 22 *Of the* Piercer.

The *Piercer* H in *Plate* 4 hath *a* the *Head*, *b* the *Pad*,

*c* the

*c* the *Stock*, *d* the *Bitt*. Its office is ſo well known, that I need ſay little to it. Only, you muſt take care to keep the Bit ſtraight to the Hole you pierce, leaſt you deform the Hole, or break the Bitt.

You ought to be provided with Bitts of ſeveral ſizes, fitted into ſo many Padds.

## § 23. *Of the* Gimblet.

The *Gimblet* is marked I, in *Plate* 4. It hath a Worm at the end of its Bit. Its Office is to make a round hole in thoſe places of your work where the *ſtock* of the Piercer by reaſon of its own ſholder, or a ſholder or Butting out upon the work will not turn about. Its Handle is held in a clutched hand, and its Bit twiſted ſtiff into your work. You muſt have them of ſeveral ſizes.

## § 24. *Of the* Àugre.

The *Augre* marked K in *Plate* 4. hath *a a* the Handle, *b* the *Bit*. Its Office is to make great round holes. When you uſe it, the ſtuff you work upon is commonly laid low under you, that you may the eaſier uſe your ſtrength upon it: For in twiſting the Bit about by the force of both your hands, on each end of the Handle one, it cuts great chips out of the ſtuff. You muſt bear your ſtrength perpendicularly ſtraight to the end of the Bitt ; as with the Piercer.

## § 25. *Of the* Hatchet.

The *Hatchet* is marked L, in *Plate* 4. Its uſe is ſo well known (even to the moſt un-intelligent) that I need not uſe many words on it, yet thus much I will ſay, Its uſe is to Hew the irregularites off

ſuch peeces of ſtuff which may be ſooner Hewn than Sawn.

When the Edge is downwards and the Handle towards you, the right ſide of its Edge muſt be Ground to a Bevil, ſo as to make an Angle of about 12 degrees with the left ſide of it: and afterwards ſet with the whetſtone, as the Irons of Plains, *&c.*

### § 26. *The Uſe of the* Saw *in general.*

In my former *Exerciſes* I did not teach you how to chuſe the Tools a Smith was to uſe, Becauſe it is a Smiths office to make them: And becauſe in thoſe *Exerciſes* I treated of making Iron work, and Steel work in general, and the making and excellency of ſome Tools in particular, which might ſerve as a general notion for the knowledge of all Smiths Workmanſhip, eſpecially to thoſe that ſhould concern themſelves with Smithing: But to thoſe that ſhall concern themſelves with Joynery, and not with Smithing; It will be neceſſary that I teach them how to chooſe their Tools that are made by Smiths, that they may uſe them with more eaſe and delight, and make both quicker and neater work with them.

All ſorts of Saws for Joyners uſe are to be ſold in moſt Iron-monger ſhops, but eſpecially in *Foſter-lane, London*: chuſe thoſe that are made of Steel, (for ſome are made of Iron) for Steel is of it ſelf is harder and ſtronger than Iron: You may know the Steel *Saws* from Iron *Saws*, Thus, The Steel *Saws* are generally ground bright and ſmooth, and are (the thickneſs of the Blade conſidered) ſtronger than Iron *Saws*: But the Iron *Saws* are only Hammer-hardned, and therefore if they could be ſo hard, yet they

they cannot be ſo ſmooth as if the irregularities of the Hammer were well taken off with the Grindſtone: ſee it be free from flaws, and very well Hammered, and ſmoothly Ground, (that is evenly Ground,) you may know if it be well Hammered by the ſtiff bending of it, and if it be well Ground, (that is evenly Ground,) it will not bend in one part of it more than in another; for if it do, it is a ſign that part where it bends moſt is either too much Ground away, or too thin Forged in that place: But if it bend into a regular bow all the way, and be ſtiff, the Blade is good: It cannot be too ſtiff, becauſe they are but Hammer hardned, and therefore often bow when they fall under unskilful hands, but never break, unleſs they have been often bowed in that place. The edge whereon the Teeth are is always made thicker than the back, becauſe the back follows the Edge, and if the Edge ſhould not make a pretty wide kerf, if the back do not ſtick in the kerf, yet by never ſo little irregular bearing or twiſting of the hand awry, it might ſo ſtop as to bow the *Saw*; and (as I ſaid before) with often bowing it will break at laſt. When workmen light of a good Blade thus qualified, they matter not much whether the Teeth be ſharp or deep, or ſet to their mind; for to make them ſo is a task they take to themſelves; And thus they perform it: They wedge the blade of the *Saw* hard into the *Whetting Block*, marked P, in *Plate* 4, with the handle towards their left hand, and the end of the *Saw* to the right, then with a three-ſquare file they begin at the left hand end, leaning harder upon the ſide of the file on the right hand than on that ſide to the left hand; ſo that they file the upper ſide of the Tooth of the Saw aſlope towards the right hand,

and the underside of the Tooth a little aslope towards the left, or almost down-right. Having filed one Tooth thus, all the rest must be so filed. Then with the *Saw wrest*, marked O in *Plate* 4. they *set* the Teeth of the Saw : that is, they put one of the Notches marked *a a a* of the *Wrest* between the first two Teeth on the Blade of the *Saw*, and then turn the Handle Horizontally a little about upon the Notch towards the end of the *Saw* ; and that at once turns the first Tooth somewhat towards you, and the second Tooth from you : Then skipping two Teeth, they again put one of the notches of the *Wrest* between the third and fourth Tooth on the Blade of the *Saw*, and then (as before) turn the Handle a little about upon the notch towards the end of the *Saw*, and that turns the third Tooth somewhat towards you, and the Fourth somewhat from you : Thus you must skip two Teeth at a time, and turn the *Wrest* till all the Teeth of the *Saw* are *set*. This *Setting* of the Teeth of the *Saw* (as workmen call it) is to make the kerf wide enough for the Back to follow the edge : and is *Set Ranker* for soft, course, cheap stuff than for hard, fine, and costly stuff : for the *Ranker* the Tooth is set, the more stuff is wasted in the kerf : and besides, if the stuff be hard it will require greater labour to tear away a great deal of hard stuff, then it will do to tear away but a little of the same stuff.

The *Pit-Saw*, is *set* so Rank for course stuff as to make a kerf of almost a quarter of an Inch, but for fine and costly stuff they set it finer to save stuff, The *Whip-Saw* is set somewhat finer than the *Pit-Saw*, the *Hand-Saw*, and the *Compaß-Saw*, finer than the *Whip-Saw* ; But the *Tennant Saw*, *Frame-saw*, and the *Bow Saw*, &c. are set fine and have

have their Teeth but very little turned over the ſides of their Blades: So that a kerf made by them is ſeldom above half a half quarter of an Inch.

The reaſon why the Teeth are filed to an angle, pointing towards the end of the *Saw*, and not towards the handle of the *Saw*, or directly ſtraight between the handle and end of the *Saw*, is, Becauſe the *Saw* is deſigned to cut only in its progreſs forwards; Man having in that activity more ſtrength to rid, and Command of his hands to guide his Work, than he can have in drawing back his *Saw*, and therefore when he draws back his *Saw*, the Work-man bears it lightly off the unſawn *Stuff*; which is an eaſe to his labour, and enables him the longer to continue his ſeveral Progreſſions of the *Saw*.

Maſter-Workmen when they direct any of their Underlins to ſaw ſuch a piece of Stuff, have ſeveral phraſes for the ſawing of it: They ſeldom ſay *Saw that piece of Stuff*; But *Draw the Saw through it*; *Give that piece of Stuff a kerf*; *Lay a kerf in that piece of Stuff*; and ſometimes, (but moſt unproperly,) *Cut* or *Slit that piece of Stuff*: For the Saw cannot properly be ſaid to cut or ſlit the Stuff; but it rather breaks or tears away ſuch parts of the Stuff from the whole, as the points of the Teeth prick into, and theſe parts it ſo tears away are proportionable to the fineneſs or rankneſs of the Setting of the Teeth.

The Excellency of Sawing is to keep the kerf exactly in the line marked out to be Sawn, without wriggling on either or both ſides; And ſtraight through the Stuff, as Work-men call it; that is, in a Geometrical term perpendicularly through the upper and underſide, if your work require it, as

moſt

moſt work does: But if your work be to be Sawn upon a Bevel, as ſome work ſometimes is, then you are to obſerve that Bevel all the length of the Stuff, *&c.*

§ 27. *The Uſe of the* Pit-Saw, *marked* M *in* Plate 4.

The *Pit-Saw* is not only uſed by thoſe Work-men that make Sawing Timber and Boards their whole buſineſs, but is alſo for ſmall matters uſed by Joyners, when what they have to do, may perhaps be as ſoon done at home, as they can carry or ſend it to the Sawyers. The manner of their working is both alike, for if it be a Board they would ſlit off a peece of Timber, or if they would take any ſquare, Quarter, or Batten, *&c.* off, they firſt ſet off their Scantlin: For Example, If it be an Inch (or more or leſs) they would take off a peece of Stuff, they open the points of their Compaſſes to an Inch meaſure on their Rule, and ſo much more as they reckon the kerf of the *Saw* will make, and from one ſide of their Stuff they ſet off at either end of the Stuff the Diſtance of the points of their Compaſſes; at this Diſtance therefore they make with the points of their Compaſſes a prick at either end of the Stuff; Then with Chaulk they whiten a line, by rubbing the Chaulk pretty hard upon it; Then one holds the line at one end upon the prick made there, and the other ſtrains the line pretty ſtiff upon the prick at the other end; then whiles the line is thus ſtrain'd, one of them between his Finger and Thumb draws the middle of the line directly upright, to a convenient height (that it may ſpring hard enough down) and then lets it go again, ſo that it ſwiftly applies to its firſt poſition

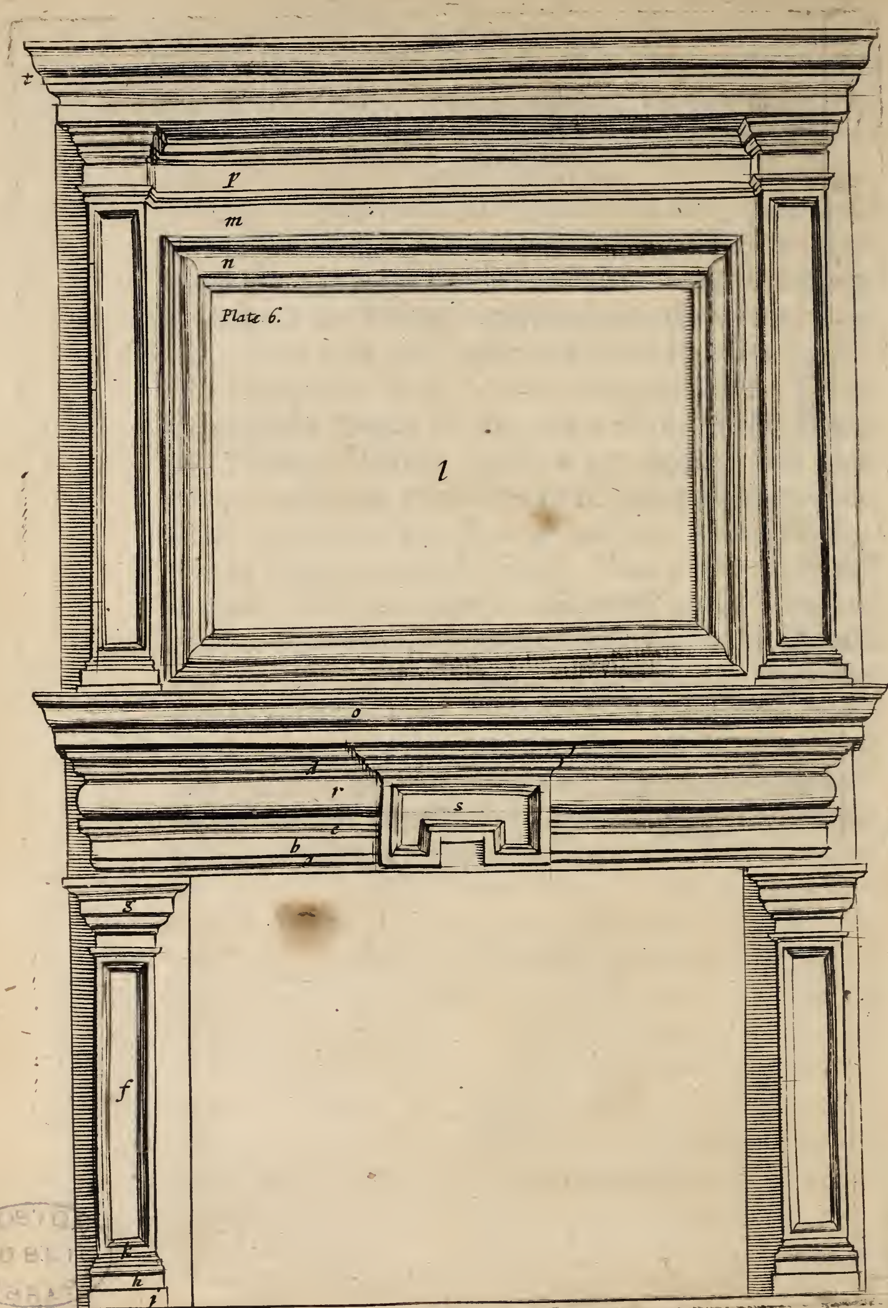
tion, and ſtrikes ſo ſtrongly againſt the Stuff that the duſt or attoms of the Chaulk that were rubbed into the Line, ſhake out of it,and remain upon the Stuff. And thus alſo they mark the under-ſide of their Stuff: This is called *Lining of the Stuff*: And the Stuff cut into thoſe lines ſhall be called *Inch-Stuff*, becauſe the Compaſſes that prickt the Stuff were opened wider by the width of the kerf than an Inch meaſure upon the Rule: But had the Compaſſes been opened but to an Inch exactly, that peece Sawn off ſhould in Workmens Language have been called *Inch prickt*, thereby giving to underſtand that it is half the breadth of the kerf thinner than an Inch: And thus they call all other Scantlins *2 Inches*, *2 ½ Inches*, *3 Inches*, &c. *Sawn*, or *Prickt*.

When two Work-men are not at hand to hold the line at both ends, he that lines it ſtrikes one point of his Compaſs, or ſometimes a Pricker, or a Nail aſlope towards that end into the prick ſet off, and putting the nooſe at the end of his line over his Compaſſes, *&c.* goes to the other end, and ſtrains his line on that prick, and ſtrikes it as before.

The Stuff being thus lined is faſtned with wedges over the *Pit*, (if the Joyner be accommodated with a *Pit*) if he have none, he makes ſhift with two high frames a little more than Man high in its ſtead, (called *great Truſſels*) with four Legs, theſe Legs ſtand ſpreading outwards,that they may ſtand the firmer: Over theſe two *Truſſels* the Stuff is laid and firmly faſtned that it ſhake not. Its outer ſide from whence the Pricks were ſet off muſt be Perpendicular, which you muſt try by a Plumb line, for ſhould the top edge of that ſide, hang never ſo litttle over the bottom edge, or the bottom edge

not

not ly ſo far out as the top edge, the Scantlin you Saw off would not be of an equal thickneſs on the Top or Bottom; Becauſe the Saw is to work exactly perpendicular. Then with the *Pit-Saw* they enter the one end of the Stuff, the *Top man* at the Top, and the *Pit-man* under him; the *Top-man* obſerving to guide the *Saw* exactly in the line; and withal drawing the *Saw* ſomewhat towards him when the *Saw* goes down; and the *Pit-man* drawing it with all his ſtrength perpendicularly down; but not ſo low that the upper and lower handles of the *Saw* ſink below both their managements: Then bearing the Teeth of the *Saw* a little off the Stuff, the *Top-man* draws the *Saw* up again, and the *Pit-man* aſſiſts or eaſes him in it, and thus they continue ſawing on till the *Saw* has run through the whole length upon the Stuff. But when the kerf is made ſo long that by the working of the *Saw* the Peeces of Stuff on either ſide will ſhake againſt one another, and ſo more or leſs hinder the eaſie progreſs of the *Saw*, they drive a Wedge ſo far in the kerf as they dare do for fear of ſplitting the Stuff, and ſo provide the Saw a freer and eaſier paſſage through the Stuff: This wedging they continue ſo oft as they find occaſion.



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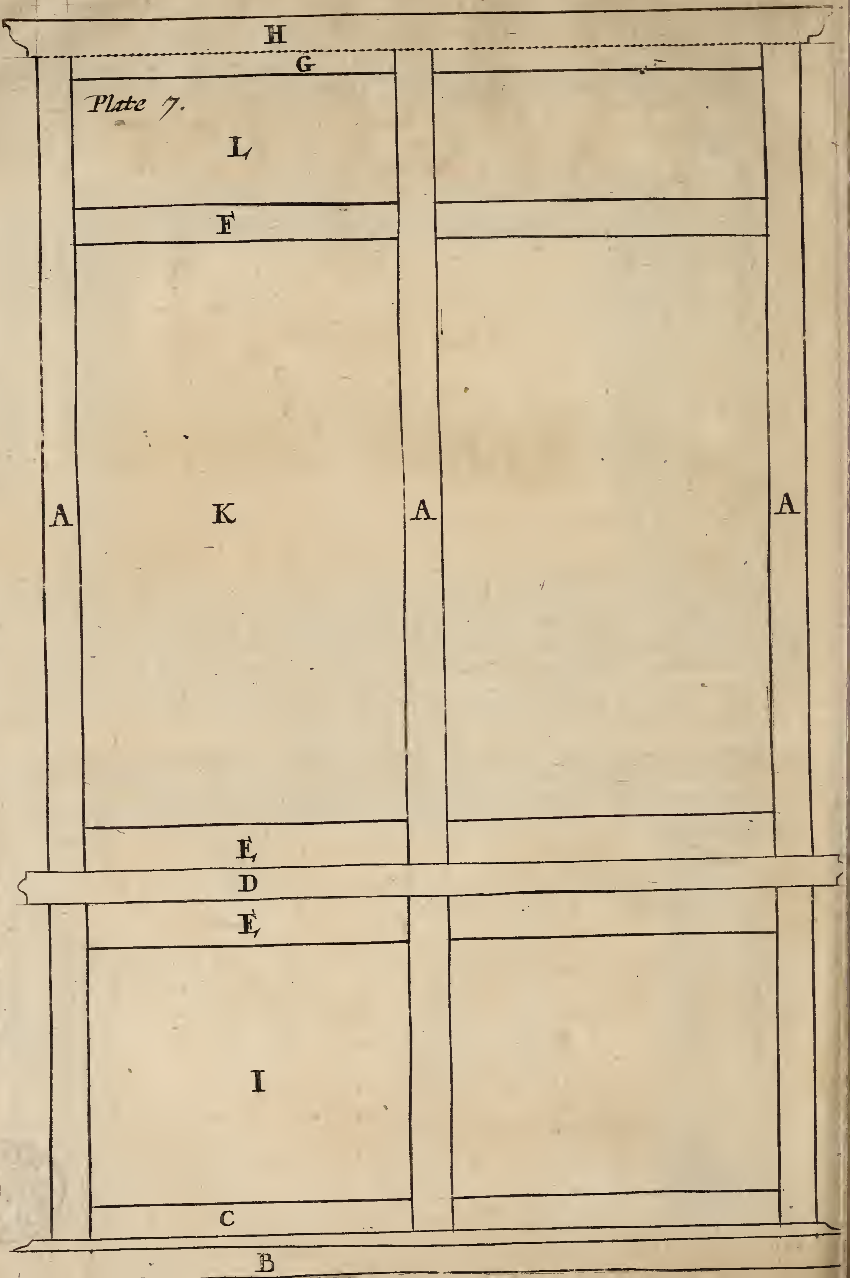
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# MECHANICK EXERCISES,

OR,

The Doctrine of

# Handy-works.

*From* June *the* 1. *to* July *the* 1. 1678. *And is intended to be Monthly continued.*

By *Joseph Moxon* Hydrographer to the King's most Excellent Majesty.

*LONDON,*

Printed for *Joseph Moxon*, at the Sign of *Atlas* on *Ludgate Hill*. 1678.

# *MECHANICK EXERCISES.*

## OR,

## The Doctrine of *Handy-works.*

## Continued in the Art of *Joynery.*

### § 28. *The Uſe of the* Whip-Saw, *marked* N *in Plate* 4.

THE *Whip-Saw* is uſed by Joyners to Saw ſuch greater peeces of Stuff that the *Hand-Saw* will not eaſily reach through; when they uſe it the Stuff is laid upon the *Truſſel*, marked O in *Plate* 5. in the Angles of it. Then two men takes each an handle of the *Saw*; He to whom the Teeth of the *Saw* points, drawing to him, and the other thruſting from him: And (as before) the *Saw* having run its length, is lifted gently over the Stuff to recover another ſtroak of the *Saw*.

### § 29. *The uſe of the* Hand-Saw, *marked* D, *the* Frame *or* Bow Saw, *the* Tennant-Saw, *marked* O *in* Plate 4.

Theſe *Saws* are acommodated for a ſingle mans uſe, and cut forward as the other *Saws* do. The office of the Cheeks made to the *Frame-Saw* is, by the twiſted Cord and Tongue in the middle to draw the upper ends of the Cheeks cloſer together that the lower end of the Cheeks may be drawn the wider aſunder, and ſtrain the Blade of the *Saw* the ſtraighter. The *Tennant Saw* being thin hath a Back to keep it from bending.

§ 30. *The Use of the* Compass-Saw, *marked* Q *Plate* 4.

The *Compass-Saw* should not have its Teeth *Set*, as other *Saws* have; but the edge of it should be made so broad, and the back so thin, that it may easily follow the broad edge, without having its Teeth *Set*; for if the Teeth be *Set*, the blade must be thin, or else the Teeth will not bow over the Blade, and if it be thin, (considering the Blade is so narrow) it will not be strong enough to abide tough work, but at never so little an irregular thrust, will bow, and at last break; yet for cheapness, they are many times made so thin that the Teeth require a setting. Its office is to cut a round, or any other Compass kerf; and therefore the edge must be made broad, and the back thin, that the Back may have a wide kerf to turn in.

§ *Of the* Rule *marked* D *in* Plate 5.

The use of the *Rule* is to measure Feet, Inches, and parts of Inches, which for that Purpose are marked upon the flat and smooth sides of the *Rule*, and numbred with Inches, and hath every Inch divided into two halfs, and every half into two quarters, and every quarter into two half quarters; so that every Inch is divided into eight equal parts, And these Inches are numbred from one end of the *Rule* to the other; which commonly is in all 24 Inches: which is a Two Foot-*Rule*.

They have commonly both Board and Timber measure, *&c.* marked upon them, for the finding both the superficial and solid Content of Board or Timber: The use of which Lines and Tables having been often taught by others, and being more

Ma-

Mathematical than Mechanical, is unproper for me to meddle with in this Place: but rather to refer to thoſe Books.

But the manual uſe of it is, either to meaſure length with it, or to draw a ſtraight line by the ſide of it, or to Try the ſtraightneſs or flatneſs of their Work with. They Try their work by applying one of its edges to the flat of the wrought ſide of their Work, and bring their Eye as cloſe as they can, to ſee if they can ſee light between the edge of the *Rule* and their Work: If they cannot they conclude their work is *Try*, and well wrought.

## § 32. *Of the* Compaſſes *marked* E *in* Plate 5.

*aa* The *Joynt*, *bb* the *Cheeks* of the Joynt, *cc* the *ſhanks*, *dd* the *Points*. Their Office is to deſcribe Circles, and ſet off Diſtances from their Rule, or any other meaſure, to their Work.

## § 33. *Of the* Glew-pot *marked* F *in* Plate 5.

The *Glew-pot* is commonly made of good thick Lead, that by its ſubſtance it may retain a heat the longer, that the Glew *Chill* not (as Work-men ſay when it cools) when it is to be uſed.

## § 34. *Of* Chuſing *and* Boyling Glew.

The cleareſt, dryeſt and moſt tranſparent Glew is the beſt: when you boyl it, break it with your Hammer into ſmall peeces, and put it into a clean Skillet or Pipkin, by no means greaſie, for that will ſpoil the clammineſs of the Glew, put to it ſo much Water as is convenient to diſſolve the Glew, and to make it when it is hot about the thickneſs of the white of an Egg: the quantity of water can-

not be aſſigned, becauſe of the different quality there is in Glew: keep it ſtirring while it is melting, and let it it not ſtick to the ſides or bottom of the Veſſel: When it is well boyled, pour it into your Glew-pot to uſe, but let your Glew-pot be very clean. When it is cold, and you would heat it again in your Glew-pot, you muſt take great care that it burn not to the ſides or bottom of the Glew-pot, for that burning either turns to a thick hard skin, or elſe to a burnt Cinder-like Subſtance, which if it mingle with the Glew will ſpoil it all; becauſe by its Subſtance it will bear the two Joynts you are to Glew together, off each other.

When (with often heating) the Glew grows too thick, you may put more water to it; but then you muſt make it very hot, leſt the Glew and water do not wholly incorporate.

Some Joyners will(when their Glew is too thick) put Small Beer into it thinking it ſtrengthens it: I have tryed it,and could never find it ſo, but think it rather makes the Glew weaker, eſpecially if the Small Beer chance to be new, and its Yeſt not well ſettled from it, or ſo ſtale that it be either Dreggy, or any whit mingled with the ſettlings of the Cask.

### § 35. *Of uſing the* Glew.

Your Glew muſt be very warm, for then it is thinneſt, and as it chills it thickens: with a ſmall Bruſh you muſt ſmear the Glew well upon the Joynt of each peece you are to Glew together; And before you ſet them as they are to ſtand, you muſt joſtle them one upon the other, that the Glew may very well touch and take hold of the Wood; and that

that the Glew on each Joynt may well incorporate. Then fit the two Joynts as they muſt ſtand; And when you ſet them by to dry, let the one ſtand upright upon the other; For if they ſtand aſlope, the weigh of the Stuff when it leans upon two extreme edges, may make one end of the Joynt *Open*.

## § 36. *Of the* Waving Engine.

The *Waving Engine* deſcribed in *Plate* 5. *Fig.* 7. Hath A B a long ſquare Plank, of about ſeven Inches broad, five Foot long, and an Inch and half thick: All along the length of this Planck on the middle between the two ſides runs a *Rabbet*, as part of it is ſeen at C: upon this Rabbet rides a *Block* with a *Groove* in its under ſide: This Block is about three Inches ſquare, and ten Inches long, having neer the hinder end of it a wooden Handle going through it, of about one Inch Diameter, as D E: At the Fore-end of this Block is faſtned a Vice, ſomewhat larger than a great Hand-Vice, as at F: The *Groove* in the Block is made fit to receive the Rabbet on the Planck.

At the farther end of the Plank is erected a ſquare ſtrong peece of Wood, about ſix Inches high, and five Inches ſquare, as G. This Square Peece hath a ſquare wide Morteſs in it on the Top, as at H. upon the top of this ſquare peece is a ſtrong ſquare flat Iron Coller, ſomewhat looſly fitted on, having two Male ſcrews fitted into two Female Screws, to ſcrew againſt that part of the Wooden Peece un-morteſſed at the Top, marked L, that it may draw the Iron Coller hard againſt the Iron marked Q and keep it ſtiff againſt the fore-ſide of the un-morteſſed Peece, marked L, when the peece

Q is

Q is ſet to its convenient heighth; and on the other ſide the ſquare wooden Peece is fitted another Iron ſcrew having to the end of its ſhank faſtned a round Iron Plate which lies within the hollow of this wooden Peece,and therefore cannot in Draft be ſeen in its proper place; But I have deſcribed it a part,as at M (fig. 9.) Its Nut is placed at M on the wooden Peece. On the farther ſide of the Wodden Peece is fitted a Wooden ſcrew called a *Knob*, as at N. Through the farther and hither ſide of the ſquare Wooden Peece is fitted a flat Peece of Iron, about three quarters of an Inch Broad, and one quarter of an Inch thick,ſtanding on edge upon the Planck; but its upper edge is filed round: (the reaſon you will find by and by:) Its hither end comes through the wooden Peece, as at O, and its farther end on the oppoſite ſide of the wooden Peece.

Upright in the hollow ſquare of the wooden peece ſtands an *Iron*, as at Q, whoſe lower end is cut into the form of the Molding you intend your work ſhall have.

In the fore ſide of this wooden Peece is a ſquare hole, as at R, called the *Mouth*.

To this Engine belongs a thin flat peece of Hard wood, about an Inch and a quarter broad, and as long as the Rabbet: It is disjunct from the Engine, and in fig. 8. is marked S S, called the *Rack*. It hath its under flat cut into thoſe faſhioned waves you intend your work ſhall have: The hollow of theſe waves are made to comply with the round edge of flat Plate of Iron marked O (deſcribed before) for when one end of the Riglet you wave, is with the Vice Screwed to the plain ſide of the Rack, and the other end put through the

Mouth

Mouth of the wooden Peece, as at T T, ſo as the hollow of the wave on the under-ſide of the Rack may ly upon the round edge of the flat Iron Plate ſet on edge as at O, and the Iron Q is ſtrong fitted down upon the Riglet, Then if you lay hold of the Handles of the Block D E, and ſtrongly draw by them, the Rack and the Riglet will both together ſlide through the Mouth of the wooden Peece: And as the Rounds of the Rack ride over the round edge of the flat Iron, the Rack and Riglet will mount up to the Iron Q, and as the Rounds of the Waves on the under ſide of the Rack ſlides off the Iron on edge, the Rack and Riglet will ſink, and ſo in a progreſſion (or more) the Riglet will on its upper ſide receive the form of the ſeveral waves on the under ſide of the Rack, and alſo the form or Molding that is on the edge of the bottom of the Iron, and ſo at once the Riglet will be both Molded and waved.

But before you draw the Rack through the Engine you muſt conſider the office of the Knob N, and the office of the Iron Screw M; For by them the Rack is ſcrewed evenly under the Iron Q. And you muſt be careful that the Grove of the Block ſlip not off the Rabbet on the Planck: For by theſe Screws and the Rabbet and Grove your work will be evenly gaged all the way (as I ſaid before) under the edge of the Iron Q, and keep it from ſliding either to the right or left hand, as you draw it through the Engine.

### § 37. *Of* Wainſcoting *Rooms.*

AAA (in *Plate* 7.) The *Stiles.* B The *Baſe,* C The *Lower Rail.* D The *Sur-Baſe.* E E. The

*Mid-*

*Middle Rail* (or *Rails*) F The *Friese-Rail.* G The *Upper-Rail.* H The *Cornice.* I The *Lying Pannel.* K The *Large Pannel.* L The *Friese Pannel.*

In Wainscoting of Rooms there is, for the most part, but two heights of Pannels used ; unless the Room to be Wainscoted be above ten foot high, as some are eleven or twelve foot High, and then three Heighths of Pannels are used : As I The *Lying Pannel,* above the *Base.* K The *Large Pannel* above the *Middle Rail* : And L The *Friese Pannel* above the *Friese Rail.*

The *Friese Rail* is to have the same bredth the *Margent* of the *Stile* hath ; The *Middle Rail* hath commonly two bredths of the *Margent* of the *Stile,* viz. one breadth above the *Sur-base,* and the other below the *Sur-base.* And the *Upper* and *Lower Rails* have also each the same breadth with the Margent of the *Stile,*

Those Moldings above the Prickt line on the Top, as H, are called the *Cornice.*

Sometimes (and especially in Low Rooms) there is no *Base* or *Sur-base* used, and then the *Middle* and *Lower-Rail* need not be so broad : For the *Middle Rail* need not be above a third part more than the *Margent* of the *Rail* : and the *Lower-Rail* you may make of what breadth you see convenient : They are commonly about three Inches and an half, or four Inches broad, yet this is no Rule : For sometimes Workmen make only a flat Plinth serve.

You may (if you will) adorn the outer edges of the *Stiles* and *Rails* with a small *Molding* : And you may (if you will) Bevil away the outer edges of the *Pannels* and leave a Table in the middle of the Panel.

*An*

## *An Explanation of* Terms *used among Joyners.*

When I first began to Print these Exercises, I marked some Terms in *Joynery* with *superiour Letters* (as Printers call them) thus a b c &c. intending at the latter end of these Exercises to have explained the Terms those Letters referr'd to; But upon consideration that those Terms might often be used in this Discourse, when the Superiour Letter was out of sight, and perhaps its position (where) forgotten; I have changed my mind, and left out the Superiour Letters beyond fol. *66.* and instead of those References give you this Alphabetical Table of Terms, by which you may always more readily find the Explanation though you often meet with the Term.

A.

***Architrave.*** see Plate *6. l.* is the ***Architrave Molding.***

***Augre*** § 24. Plate 4. fig. K.

B.

***Base.*** See Plate *6. h.* And Plate 7. B.

***Bead.*** See Plate 6. *a.*

***Bed-molding.*** See Plate *6. d.*

***Basil.*** The Basil is an angle the edge of a Tool is ground away to. See fol. 71.

***Batten.*** Is a Scantling of stuff either two, three or four Inches Broad: and is seldom above an Inch thick: and the length unlimmitted.

***Beak.*** The end of the Hold-fast. See fol. *60, 61.*

***Bench-Screw.*** See Plate 4. A *g.* and fol. 60.

***Bevil.*** Any sloping angle that is not a square, is called a Bevil. See fol. 60, 85. § 19. and Plate 4. F.

***Bitt.*** See § 22.

***Bow-saw.*** Plate 4. O.

## C

*Capital.* See Plate 6. *g.*

*Cast.* Stuff is ſaid to Caſt or warp when by its own droughth or moiſture or the droughth or moiſture of the Air or other accident it alters its flatneſs and ſtraightneſs.

*Clamp.* When a Peece of Board is fitted with the Grain to the end of another peece of Board croſs the Grain the firſt Board is *Clamp't.* Thus the ends of Tables are commonly Clamp't to preſerve them from warping.

*Compaſs ſaw.* See fol. *9.* and Plate 4. fig. R.

*Cornice.* See Plate 6. *q.* and Plate 7. H.

*Croſs-grained ſtuff.* Stuff is Croſs-grained when a Bough or ſome Branch ſhoots out on that part of the Trunck of the Tree; For the Bough or branch ſhooting forwards, the Grain of that branch ſhoots forwards alſo, and ſo runs a groſs the Grain of the Trunck; and if they be well grown together, it will ſcarce be perceived in ſome ſtuff, but in working; yet in Deal Boards, thoſe Boughs, or branches are Knots, and eaſily Perceiv'd, and if it grew up young with the Trunk, then inſtead of a Knot you will find a Curling in the Stuff when it is wrought.

*Curling-ſtuff.* If the Bough or Branch that ſhoots out of the Trunk of a Tree be large, and the ſtuff in that place ſawn ſomewhat aſlope, when that ſtuff comes under the Plain you will find a Turning about or Curling on that place upon the ſtuff; and in a ſtraight progreſs of the Plain the Iron will cut *with*, and ſuddenly *a-croſs* the Grain, and that more or leſs as the Bough grew in the youth of the Tree, or grew more or leſs upright, or elſe

else sloping to the Trunck, or was sawn so. Such Stuff therefore is called *Curling-stuff.*

D.

*Door-case.* Is the Fram'd work about the Door.

*Double-Screw.* See fol. 60. Plate 4. fig. *g.* on the work bench A.

F.

*Facia*, See Plate 6. *b.*

*Fence.* See § 8. Use of the Plow, and Pl. 4. fig. B 6.

*Fine set.* The Irons of Plains are set Fine, or Ranck. They are set fine, when they stand so shallow below the sole of the Plain that in working they take off a thin shaving. See § 3.

*Flat Friese.* See Plate 6. *p.*

*Fore-Plain.* See § 2. and Plate 4 B 1.

*Former.* See § 10. and Plate 4. C 1. C 3.

*Frame.* See fol. 59, 60.

*Frame Saw.* See § 28. and Plate 4. O.

*Free stuff.* See § 3.

*Friese.* See Plate 6. *p.*

*Friese Pannel.* See Plate 7. L.

*Friese Rail.* See plate 7. F.

*Frowy stuff.* See § 3.

G.

*Gage.* See § 21. and Plate 4. G.

*Gimblet.* See § 23. and Plate 4 I.

*Gouge.* see § 14. C 6.

*Groove.* see fol. 69.

H.

*Hammer-hard.* See Numb. III. fol 58.

*Handle.* See § 15. and Plate 4. D *a.*

*Hard stuff.* See § 3.

*Hatchet.* See § 25. Plate 4 L.

*Head.* See § 22. Plate 4. H *a.*

*Hold-fast.* See § 1. Plate 4. A *d.*

*Hook.* See § 1 Plate 4. A *b.*

*Husk.* See Plate 6. *n.*

I

*Inner-square.* See § 15. and Plate 4. D *d.*

*Joynt.* See fol 59.

*Joynter.* See § 4. and Plate 4. B 2.

*Iron.* See § 2. and Plate 4. B 1 *d.*

K.

*Kerf.* The Sawn-away slit between two peeces of stuff, is called a kerf: See fol 95.

*Knob.* See § 36. fol. 104. and Plate 5. fig. 7. N.

*Knot.* See Plate 6. *o.*

L.

*Large Pannel.* See Plate 7. K.

*Lying Pannel.* See Plate 7. I.

*Lower Rail.* See Plate 7. H.

M.

*Margent.* See Plate 7. at AAA the flat bredth of, the Stiles besides the Moldings is called the Margent of the stiles.

*Middle Rail.* See Plate 7 E E.

*Miter.* See fol. 60.

*Miter Box,* See § 20. and Plate 5. fig. 1.

*Miter square.* See § 18. and Plate. 4. E.

*Moldings.* The several wrought-work made with Plains on wood, is called *Moldings.* See Plate 6.

*Molding Plains.* See § 9.

*Mortess.* Is a square hole cut in a peece of stuff, to entertain a Tennant fit to it. see § 17.

*Mortess Chissel.* see § 13. and Plate 4. C 5.

*Mouth.* see § 2. B 7. *a* The Mouth.

O.

*Ogee.* See Plate 6. *c.*

*Oval.* See § 21. and Plate 4. G *b.*

*Outer Square.* See § 15. and Plate 4. D *c.*

P.

*Pad.* See § 22 and Plate 4. H *b*

Pan-

*Pannel.* In Plate 7. I K L are Pannels, but diſtinguiſhed by their poſitions.

*Pare.* The ſmooth cutting with the Paring Chiſſel is called *Paring.*

*Paring Chiſſel.* See § 11. and Plate 4. C 2.

*Pilaſter.* See Plate 6. *f.*

*Peircer*, See § 22. and Plate 4. H.

*Pit-man.* The Sawyer that works in the Pit, is called the Pit-man,

*Pit-Saw.* The Pit-Saw is a great Saw fitted into a ſquare Frame ; as in Plate 4. M is a Pit-Saw.

*Planchier.* In Pl.6 between *d* and *e* is the Planchier.

*Plinth.* See Plate 6.

*Plow.* See § 8. and Plate 4. B 6.

*Pricker.* Is vulgarly called an Awl : yet for Joyners uſe it hath moſt commonly a ſquare blade, which enters the Wood better than a round Blade will ; becauſe the ſquare angles in turning it about, breaks the Grain and ſo the Wood is in leſs danger of ſplitting.

R.

*Rabbet.* See § 7.

*Rabbet Plain.* See § 7. and Plate 4. B 5.

*Rack* See Plate 5. Fig. 8. Read § 36.

*Rail.* See Plate 7. AAA.

*Ranck.* The Iron of a Plain is ſaid to be *ſet Ranck*, when its edge ſtands ſo far below the Sole of the Plain, that in working it will take off a thick ſhaving. See § 3.

*Ranck-ſet*, See Ranck.

*Range.* The ſide of any work that runs ſtraight, without breaking into angles, is ſaid to *run Range* : Thus the Rails and Pannels of one ſtraight ſide of Wainſcoting is ſaid to *run Range.*

Re-

*Return.* The ſide that falls away from the Fore-ſide of any Straight or Range-work, is called the *Return.*

*Riglet.* Is a flat thin ſquare peece of Wood: Thus the peeces that are intended to make the Frames for ſmall Pictures, *&c.* before they are Molded are called *Riglets.*

*Rub.* See fol. 64.

S.

*Saw-wreſt.* See § 26 fol. 94. and Plate 4 O.

*Scantlin.* The ſize that your Stuff is intended to be cut to.

*Scribe.* When Joyners are to fit a ſide of a peece of Stuff againſt the ſide of ſome other peece of Stuff, and the ſide of the peece of Stuff they are to fit to is not regular; To make theſe two peeces of Stuff joyn cloſe together all the way, they Scribe it, (as they phraſe it,) thus; They lay the peece of Stuff they intend to Scribe cloſe againſt the other peece of Stuff they intend to Scribe to, and open their Compaſſes to the wideſt diſtance, theſe two peeces of Stuff bear off each other: Then (the Compaſſes moving ſtiff in their Joynt) they bear the point of one of the ſhanks againſt the ſide they intend to Scribe to, and with the point of the other ſhank they draw a line upon the Stuff to be Scribed; and then the points of the Compaſſes remaining unremov'd, and your hand carried evenly along by the ſide of the peece to be Scribed to, that line ſcribed upon the peece intended to be Scribed ſhall be parallel to the irregular ſide intended to be Scribed to: And if you work away your Stuff exactly to that line, when theſe two peeces are put together, they ſhall ſeem a Joynt.

*Shoot a Joynt.* See fol. 59.

Skew-

*Skew-former.* See § 12. and Plate 4. C 4.

*Smoothing Plain.* See § 6. and Plate 4. B 4.

*Sole.* See Plate 4. B 7. *b a b.* The under-ſide of a Plain is called the *Sole.*

*Square.* See § 15. and Plate 4. D.

*Staff.* See § 21. and Plate 4. G *c.*

*Staves.* See § 8. and Plate 4. B 6. *a a.*

*Stile.* The upright Peeces AA in Pl. 7. are *Stiles.*

*Stock.* See § 22. and Plate 4. H *c.*

*Stops.* In Plate 6 *kk* are *Stops.*

*Stuff.* The Wood that Joyners work upon they call in general *Stuff.*

*Sur-baſe.* In Plate 7. D is the *Sur-baſe.*

*Swelling-Frieſe.* In Plate 6. *r* is the *Swelling-Frieſe.*

T.

*Table.* In Plate 6. *ſ* is the *Table.*

*Taper.* All ſorts of Stuff or work that are ſmaller at one end than at the other, and diminiſh gradually from the biggeſt end, is ſaid to be *Taper.*

*Tennant.* Is a ſquare end fitted into a Morteſs. See § 17.

*Tennant Saw.* In Plate 4. O would be a Tennant Saw, were the flat of the Blade turned where the edge there ſtands.

*Tongue.* See § 16. and Plate 4. D *b.*

*Tooth.* See § 21. and Plate 4. G *a.*

*Top-man.* Of the two Sawyers, the uppermoſt is called the Top-man.

*Tote.* See § 2. and Plate 4. B 1 *a.*

*Traverſe.* See fol. 65.

*Truſſel.* See fol. 97. and Plate 5. Fig. 3.

*Try.* See § 31.

V.

*Vaws-Cornice.* See Plate 6. *e.*

*Upper Cornice.* See Plate 6. *t.*

W.

W.

*Warp*. The ſame that Caſt is.
*Waving Engine*. Se § 36. and Plate 5.
*Wedge*. See § 2. and Plate 4. B 1. *c*.
*Whetting-Block*. See Plate 4. P.
*Whip-Saw*. See Plate 4. N.
*Wreſt*. See § 26. and Plate 4. Q.

Thus much of Joynery. The next Exerciſes will (God willing) be of *Carpentery*.

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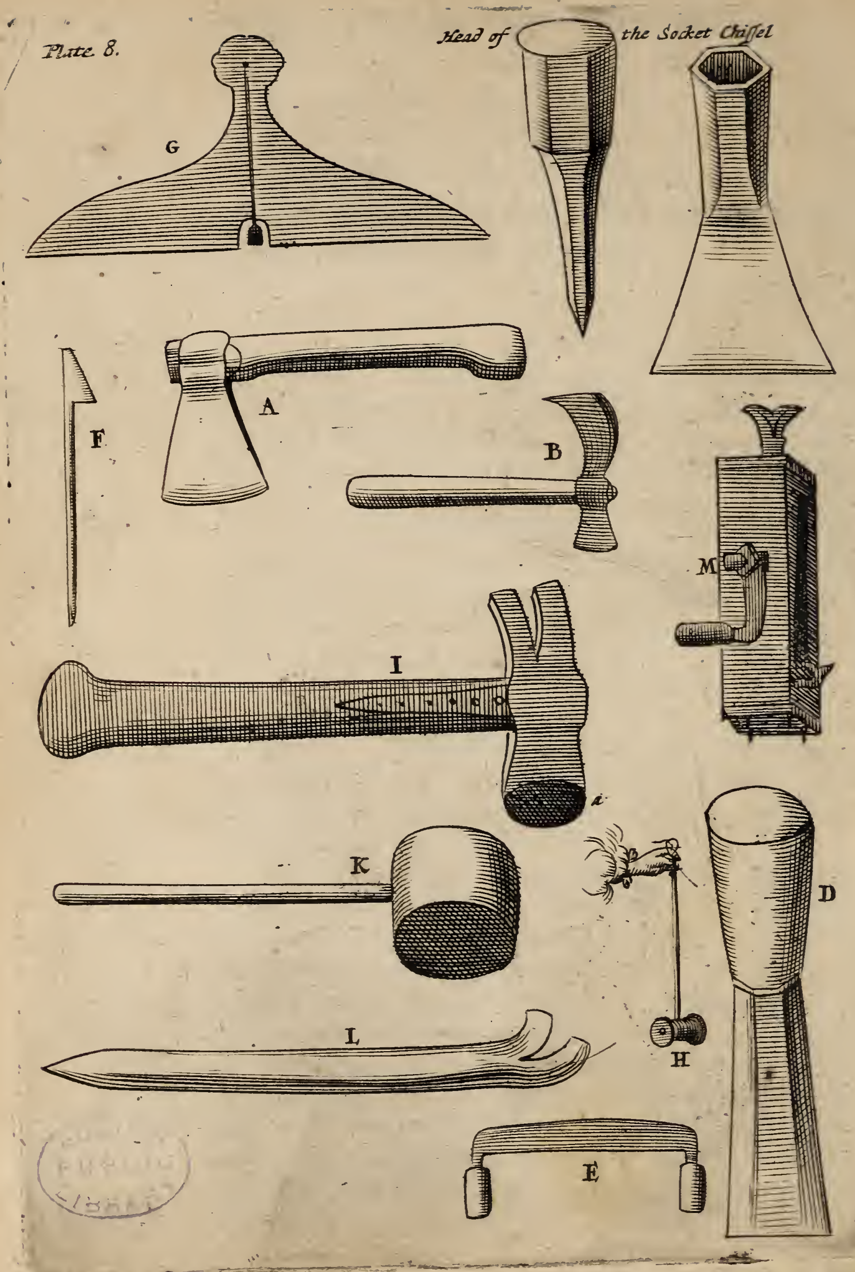


Plate 8.
Head of the Socket Chissel
G
A
F
B
M
I
a
K
D
H
L
E


Plate. 9.
B
C
D
E
A

Numb. VII.

# MECHANICK EXERCISES.

OR,

The Doctrine of

# Handy-works.

Applyed to the Art of House-Carpentry.

By *Joseph Moxon*, a Member of the Royal Society, and Hydrographer to the King's most Excellent Majesty.

*LONDON*,

Printed for *Joseph Moxon*, at the Sign of the *Atlas* on *Ludgate Hill*. 1679.

# *MECHANICK EXERCISES,*

## O R,

## The Doctrine of *Handy-works*: applied to the Art of *House-Carpentery.*

---

BEing now come to exercise upon the *Carpenters* Trade, it may be expected by some that I should insist upon *Architecture*, it being so absolutely necessary for Builders to be acquainted with: But my Answer to them is, that there are so many Books of Architecture extant, and in them the Rules so well, so copiously, and so completely handled, that it is needless for me to say any thing of that Science: Nor do I think any man that should, can do more than collect out of their Books, and perhaps deliver their meanings in his own words. Besides, *Architecture* is a Mathematical Science, and therefore different from my present undertakings, which are (as by my Title) Mechanick Exercises: yet because Books of Architecture are as necessary for a Builder to understand as the use of Tools; and lest some Builders should not know how to enquire for them, I shall at the later end of *Carpentery* give you the Names of some Authors, especially such as are printed in the English Tongue.

Some may perhaps also think it had been more proper for me in these Exercises to have introduced

*Carpentery* before *Joynery*, because Necessity (the Mother of Invention) did doubtless compel our Forefathers in the beginning to use the conveniency of the first, rather than the extravagancy of the last. I confess, I considered it my self, and had in my own reason been persuaded to it, but that I also considered, that the Rules they both work by are upon the matter the same, in *Sawing*, *Mortessing*, *Tenanting*, *Scribing*, *Paring*, *Plaining*, *Moulding*, *&c.* and likewise the Tools they work with the same, though some of them somewhat stronger for Carpenters use than they need be for Joyners; because Joyners work more curiously, and observe the Rules more exactly than Carpenters need do. And therefore I say it was, that I began with Joyners before Carpentry; for he that knows how to work curiously, may when he lists work slightly; whenas they that are taught to work more roughly, do with greater difficulty perform more curious and nice work. Thus we see Joyners work their Tables exactly flat and smooth, and shoot their Joynts so true, that the whole Table shews all one piece: But the Floors Carpenters lay, are also by the Rule of Carpentry to be laid flat and true, and shall yet be well enough laid, though not so exactly flat and smooth as a Table.

Yet though the Rules Joyners and Carpenters work by are so near the same, and the Tools they work with, and Stuff they work upon, the same; yet there are many Requisites proper to a Carpenter, (especially a Master Carpenter) that a Joyner need take little notice of, which after I have described the Carpenters Tools that are not exprest among the Joyners, I shall speak to.

Sect.

§ 1. *Of ſeveral Tools uſed in Carpentery, that are not uſed in Joynery. And firſt of the* Ax.

THe *Ax* marked *A* in *Plate* 8. is (as you ſee) different from what the Joyners Hatchet is; both in ſize and form; theirs being a light Hatchet, with a Bazil edge on its left ſide, becauſe it is to be uſed with one hand, and therefore hath a ſhort Handle: But the Carpenters *Ax* being to hew great Stuff, is made much deeper and heavier, and its edge tapering into the middle of its Blade. It hath a long Handle, becauſe it is uſed with both their hands, to ſquare or bevel their Timbers.

When they uſe the Ax, the Timber hath commonly ſome Bauk or Log laid under it near each end, that the edge of the Ax may be in leſs danger of ſtriking into the ground, when they hew near the bottom of the Timber. And they commonly ſtand on that ſide the Timber they hew upon.

§. 2. *Of the* Adz, *and its uſe.*

THe *Adz* marked *B* in *Plate* 8. hath its Blade made thin, and ſomewhat arching. As the Ax hath its edge parallel to its Handle, ſo the *Adz* hath its edge athwart the Handle, and is ground to a Baſil on its inſide to its outer edge: wherefore when it is blunt they cannot well grind it, unleſs they take its Helve out of its Eye.

Its general uſe is to take thin Chips off Timber or Boards, and to take off thoſe irregularities that the Ax by reaſon of its form cannot well come at; and that a Plain (though rank ſet) will not make riddance enough with.

It is moſt uſed for the taking off the irregularities on the framed work of a Floor, when it is framed and pind together, and laid on its place; for that lying flat under them, the edge of the Ax being parallel to its Handle (as aforeſaid) cannot come at the irregularities to take them off; but the *Adz* having its edge athwart the Handle will. Again, upon ſome Poſts framed upright, and range with other framed work cloſe to it, the edge of the *Ax* cannot come at the irregularities (for the reaſon aforeſaid) but the *Adz* will. And the like for the irregularities of framed work on a Ceiling, &c.

When they work upon the framed work of a Floor, they take the end of the Handle in both their hands, placing themſelves directly before the irregularity, at a ſmall diſtance, ſtradling a little with both their Legs, to prevent danger from the edge of the *Adz*, and ſo by degrees hew off the irregularity. But if they hew upon an Upright, they ſtand directly before it.

They ſometimes uſe the *Adz* upon ſmall thin Stuff, to make it thinner, (but this is many times when the Ax or ſome other properer Tool lies not at hand) and then they lay their Stuff upon the Floor, and hold one end of it down with the Ball of the Foot, if the Stuff be long enough; if not, with the ends of their Toes, and ſo hew it lightly away to their ſize or form, or both.

## § 3. *Of Carpenters* Chiſſels *in general.*

THough Carpenters for their finer work uſe all the ſorts of *Chiſſels* deſcribed in *Exerciſe* 4. yet are not thoſe ſorts of *Chiſſels* ſtrong enough for their rougher and more common work, and therefore they alſo uſe a ſtronger ſort of *Chiſſels*; and diſtinguiſh them by the name of *Socket Chiſſels:* For whereas thoſe *Chiſſels* Joyners uſe have their wooden heads made hollow to receive the Iron Sprig above the Shoulder of the Shank, Carpenters have their Shank made with an *hollow Socket* at its top, to receive a ſtrong wooden Sprig made to fit into that Socket, with a ſquare Shoulder above it, the thickneſs of the Iron of the Socket, or ſomewhat more; which makes it much more ſtrong, and able to endure the heavy blows of the *Mallet* they lay upon the head of the *Chiſſel*. And the Shanks and Blades are made ſtronger for Carpenters uſe than they are for Joyners.

Of theſe *Socket Chiſſels* they have of the ſeveral ſorts deſcribed in Joynery, though not all ſeverally diſtinguiſh'd by their names; for they call them *Half Inch*, *Three quarter Inch Chiſſels*, *Inch and half*, *Two Inch* to *Three Inch Chiſſels*, according to the breadth of the Blade. But their uſes are the ſame mentioned in Joynery, though the manner of uſing them be ſomewhat different too: For as I told you in Joynery, the Joyners preſs the edge of the Blade into the Stuff with the ſtrength of their Shoulders, but the Carpenters with the force of the blows of the Mallet. And the Joyners guide their *Chiſſels* differently from what the Carpenters do their *Socket Chiſſels*; for the Joyners hold the Shank and Blade of their *Chiſſels* as

I described in *Numb.*4. *Sect:*11. but the Carpenters hold the Shank of their *Chissels* in their clutched left hand, and beat upon the Head with the *Mallet* in the right. See the Figure of the *Socket Chissel* in *Plate* 8.C. with its Head *a* out of the Socket.

## § 4. *Of the* Ripping Chissel, *and its use.*

THe *Ripping Chissel* described *Plate* 8.D. is a *Socket Chissel*, and is about an Inch broad, and hath a blunt edge. Its edge hath not a *Basil* as almost all other *Chissels* have, and therefore would more properly be called a *Wedge* than a *Chissel*. But most commonly Carpenters use an old cast off *Chissel* for a *Ripping Chissel*.

Its office is not to cut wood as others do, but to *rip* or *tear* two pieces of wood fastned together from one another, by entering the blunt edge of it between the two pieces, and then knocking hard with the Mallet upon the head of the Handle, till you drive the thicker part of it between the two pieces, and so force the power that holds them together (be it Nails or otherwise) to let go their hold: For its blunt edge should be made of Steel and well tempered, so that if you knock with strong blows of the Mallet the *Chissels* edge upon a Nail (though of some considerable substance) it may cut or break it short asunder. If you cannot at once placing the *Ripping Chissel* part the two pieces, you must use two *Ripping Chissels*, placing the second at the remotest entrance in the breach, and driving that home will both open the breach wider, and loosen the first *Ripping Chissel*, so that you may take it out again, and place it further in the breach: And so you must con-

coutinue edging further and further, till you have ſeparated your intended pieces.

It is ſometimrs uſed when Carpenters have committed error in their work, and muſt undo what they did, to mend it. But it is generally uſed in all alterations and old work.

### § 5. *Of the* Draw-knife, *and its uſe.*

THe *Draw-knife* deſcribed *Plate* 8. E. is ſeldom uſed about Houſe-building, but for the making of ſome ſorts of Houſhold-ſtuff; as the Legs of Crickets, the Rounds of Ladders, the Rails to lay Cheeſe or Bacon on, &c.

When they uſe it, they ſet one end of their work againſt their Breaſt, and the other end againſt their Work-bench, or ſome hollow angle that may keep it from ſlipping, and ſo preſſing the work a little hard with their Breaſt againſt the Bench, to keep it ſteddy in its poſition, they with the Handles of the *Draw-knife* in both their hands, enter the edge of the *Draw-knife* into the work, and draw Chips almoſt the length of their work, and ſo ſmoothen it quickly.

### § 6. *Of* Hook-Pins, *and their uſe.*

THe Hook-Pin is deſcribed *Plate* 8. F. *a* the *Pin*, *b* the *Hook*, *c* the *Head*. Its office is to pin the Frame of a Floor or Frame of a Roof together, while it is framing, or while it is fitting into its poſition. They have many of theſe *Hook-Pins* to drive into the ſeveral angles of the Frame. Theſe they drive into the Pin-holes through the Morteſſes and Tennants, and being made taper, do with a Hammer ſtriking on

the

the bottom of it knock it out again; or they most commonly strike under the Hook, and so knock it out. Then if the Frame lie in its place, they pin it up with wooden Pins.

§ 7. *Of the* Level, *and its use.*

THe *Level* described *Plate* 8. G. *a a* the *Level*, *b* the *Plumbet*, *c* the *Plumb-line*, *d d* the *Perpendicular* mark'd from the top to the bottom of the Board. The *Level* is from two to ten foot long, that it may reach over a considerable length of the work. If the *Plumb-line* hang just upon the *Perpendicular d d*, when the *Level* is set flat down upon the work, the work is Level: But if it hang on either side the *Perpendicular*, the Floor or work must be raised on that side, till the *Plumb-line* hang exactly upon the *Perpendicular*.

§ 8. *Of the* Plumb-line, *and its use.*

THe *Plumb-line* is described *Plate* 8. H. *a* the *Line Rowl*, *b* the *Line*. It is used to try the upright standing of Posts, or other work that is to stand perpendicular to the Ground Plot; and then they draw off so much Line as is necessary, and fasten the rest of the Line there, upon the *Line Rowl* with a Slip-knot, that no more Line turn off. They hold the end of the Line between their Finger and Thumb half the Diameter of the *Line Rowl* off one corner of the Post or work, and if the *Line* and Corner of the Post be parallel to each other, the Post is upright: But if the Post be not parallel to the *Line*, but its bottom stands more than half the Diameter of the *Line Rowl* from

from the *Line*, the Poſt hangs ſo much over the bottom of the Poſt on that ſide the *Line* bears off, and muſt be forced backwards till the ſide of the Poſt and the *Line* become parallel to each other. But if the bottom of the corner of the Poſt ſtand out from the top of the *Line*, the Poſt muſt be forced forwards to comply with the *Line*.

### § 9. *Of the* Hammer, *and its uſe.*

THe *Hammer* is deſcribed *Plate* 8. I. *a* the *Face*, *b* the *Claw*, *c c* the *Pen* at the return ſides of the *Claw*. This Tool was forgot to be deſcribed in *Joynery*, though they uſe *Hammers* too, and therefore I bring it in here. Its chief uſe is for driving Nails into work, and drawing Nails out of work.

There is required a pretty skill in driving a Nail; for if (when you ſet the point of a Nail) you be not curious in obſerving to ſtrike the flat face of the *Hammer* perpendicularly down upon the Perpendicular of the Shank, the Nail (unleſs it have good entrance) will ſtart aſide, or bow, or break; and then you will be forced to draw it out again with the *Claw* of the *Hammer*. Therefore you may ſee a reaſon when you buy a *Hammer*, to chuſe one with a true flat *Face*.

A little trick is ſometimes uſed among ſome (that would be thought cunning Carpenters) privately to touch the head of the Nail with a little Ear-wax, and then lay a wager with a ſtranger to the Trick, that he ſhall not drive that Nail up to the Head with ſo many blows. The ſtranger thinks he ſhall aſſuredly win, but does aſſuredly loſe; for the *Hammer* no ſooner touches the Head of the Nail, but inſtead of entring

the wood it flies away, notwithstanding his utmost care in striking it downright.

§ 10. *Of the* Commander, *and its use.*

THe *Commander* is described *Plate* 8. K. It is indeed but a very great wooden *Mallet*, with an Handle about three foot long, to use in both the hands.

It is used to knock on the Corners of Framed work, to set them into their position. It is also used to drive small wooden Piles into the ground, &c. or where greater Engines may be spared.

§ 11. *Of the* Crow, *and its use.*

THe *Crow* is described in *Plate* 8. L. *a* the *Shank*, *b b* the *Claws*, *c* the *Pike-end*. It is used as a *Lever* to lift up the ends of great heavy Timber, when either a Bauk or a Rowler is to be laid under it; and then they thrust the *Claws* between the Ground and the Timber, and laying a Bauk or some such stuff behind the *Crow*, they draw the other end of the Shank backwards, and so raise the Timber.

§ 12 *Of the* Drug, *and its use.*

THe *Drug* described *Plate* 9. A. is made somewhat like a low narrow Carr. It is used for the carriage of Timber, and then is drawn by the Handle *a a*, by two or more men, according as the weight of the Timber may require.

There are also some Engines used in Carpentery, for the management of their heavy Timber, and hard

Labour, *viz.* the *Jack*, the *Crab*, to which belongs Pullies and Tackle, &c. Wedges, Rowlers, great Screws, &c. But I ſhall give you an account of them when I come to the explanation of Terms at the later end of *Carpentery.*

§ 13. *Of the* Ten-foot Rod, *and thereby to meaſure and deſcribe the* Ground-plot.

WE ſhall begin therefore to meaſure the *Ground-plot*, to which Carpenters uſe a *Ten-foot Rod* for expedition, which is a Rod about an Inch ſquare, and ten foot long; being divided into ten equal parts, each part containing one foot, even as the *Two-foot Rule* deſcribed in *Exerciſe* 6. § 31. is divided into 24 equal parts, and their Sub-diviſions.

With this *Rod* they meaſure the length and breadth of the *Ground-plot* into Feet, and if there be odd Inches, they meaſure them with the *Two-foot Rule*. Their meaſure they note down upon a piece of paper, and having conſidered the ſituation of the Sides, *Eaſt*, *Weſt*, *North*, and *South*, they draw on Paper their ſeveral Sides accordingly, by a ſmall Scale, either elected or elſe made for that purpoſe. They may elect their *Two-foot Rule* for ſome Plots; for an Inch and an half may commodiouſly ſerve to ſet off one Foot on ſome ſmall *Ground-plots*, and then you have the Inches to that Foot actually divided by the marks for the half quarters on the *Two-foot Rule*. But this large Scale will ſcarce ſerve to deſcribe a *Ground-plot* above ten Foot in length, becauſe a ſmall ſheet of Paper is not above 15 or 16 Inches long, and therefore one ſheet of Paper will not contain it if the *Ground-plot* be longer: Therefore if you make every half quarter of an

Inch to be a Scale for two Inches, a ſheet of Paper will contain 20 Foot in length: And if you make every half quarter of an Inch to be a Scale for four Inches, a ſheet of Paper will contain 40 Foot. And thus by diminiſhing the Scale, the ſheet of Paper will contain a greater number of Feet.

But having either elected, or elſe made your Scale, you are to open your Compaſſes to the number of Feet on your Scale your *Ground-plot* hath in length, and then transfer that diſtance to your Paper, and to draw a ſtreight Line between the two Points, and mark that ſtreight Line with *Eaſt*, *Weſt*, *North*, or *South*, according to the ſituation of that ſide of the *Ground-plot* it repreſents. Then again open your Compaſſes to the number of Feet on your Scale one of the adjoyning ſides contains, and transfer that diſtance alſo to your Paper, and draw a Line between the two points, and note its ſituation of *Eaſt*, *Weſt*, *North*, or *South*, as before. Do the like by the other ſides; and if either a Quirk or any Addition be added to the Building, on any ſide of your *Ground-plot*, you muſt deſcribe it alſo proportionably.

Then you are to conſider what Apartments or Partitions to make on your *Ground-plot*, or ſecond or third Story, and to ſet them off from your Scale, beginning at your intended Front. As for example, ſuppoſe your *Ground-plot* be a Long-ſquare, 50 Foot in length, and 20 Foot wide: This *Ground-plot* will contain in its length two good Rooms, and a Yard behind it 10 Foot long. If you will, you may divide the 40 Foot into two equal parts, ſo will each Room be 20 Foot ſquare: Or you may make the Rooms next the Front deeper or ſhallower, and leave the remainder for the Back Room: As here the Front

Room

Room is 25 Foot, and the Back Room 15 Foot deep, and a ſetting off of 8 Foot broad and 10 Foot long taken out of the Yard, for a Buttery below ſtairs (if you will) and Cloſets above ſtairs over it. But what width and depth ſoever you intend your Rooms ſhall have, you muſt open your Compaſſes to that number of Feet on your Scale, and ſet off that Diſtance on the *Eaſt*, *Weſt*, *North*, or *South* Line, according to the Situation of that ſide it repreſents on your *Ground-plot.* If you ſet it off the *Eaſt* Line, you muſt alſo ſet it off on the *Weſt*; if on the *North* Line, you muſt alſo ſet it off on the *South* Line: Becauſe between the two Settings off on the *Eaſt* and *Weſt* Lines, or *North* or *South* Lines, you muſt draw a ſtreight Line of the length of your intended Partition. And in this manner you muſt from every Partition draw a Line in its proper place on the Paper, by meaſuring the Diſtances each Partition muſt have from the outſide of the *Ground-plot.*

And thus you are alſo to deſcribe by your Scale your Front, and ſeveral ſides of the Carcaſe; allowing the *Principal Poſts*, *Poſts*, *Enterduces*, *Quarterings*, *Braces*, *Gables*, *Doors*, *Windows*, and *Ornaments*, their ſeveral ſizes, and true poſitions by the Scale: Each ſide upon a Paper by it ſelf: Unleſs we ſhall ſuppoſe our Maſter Workman to underſtand *Perſpective*; for then he may on a ſingle piece of Paper deſcribe the whole Building, as it ſhall appear to the Eye at any aſſigned ſtation.

### § 14. *Of* Foundations.

HAving drawn the *Draft*, the Maſter Workman is firſt to cauſe the Cellars to be dug, if the Houſe ſhall have Cellars. And then to try the Ground, that it be all over of an equal firmneſs, that when the weight

of

of the Building is ſet upon it, it may not ſink in any part. But if the Ground be hollow or weaker in any place, he ſtrengthens it, ſometimes by well ramming it down, and levelling it again with good dry Earth, Lime-Core, Rubbiſh, &c. or ſometimes with ramming in Stones, or ſometimes with well Planking it; or moſt ſecurely by driving in Piles. But driving in of Piles is ſeldom uſed for Timber Houſes, but for Stone or Brick Houſes, and that but in few places of *England* neither, but where the Ground proves *fenny* or *mooriſh*. Therefore a further account ſhall be given of Foundations, when I come to exerciſe upon *Maſonry*, &c.

Then are the Cellar Walls to be brought up by a *Bricklayer* with *Brick*; for ſmall Houſes two Bricks thick, for bigger two and and an half Bricks thick, or three or four Bricks thick, according to the bigneſs of the Houſe, and quality of the Ground, as I ſhall ſhew when I come to Exerciſe on *Bricklaying*.

But if the Houſe be deſigned to have no Cellars (as many Countrey Houſes have not) yet for the better ſecuring the Foundation, and preſerving the Timber from rotting, Maſter Workmen will cauſe three or four or five courſe of Bricks to be laid, to lay their *Ground-plates* upon that Foundation.

The Foundation being made good, the Maſter-workman appoints his under-workmen their ſeveral *Scantlins*, for *Ground-plates*, *Principal Poſts*, *Poſts*, *Breſſummers*, *Girders*, *Trimmers*, *Joyſts*, &c. which they cut ſquare, and frame their Timbers to, as has been taught in the ſeveral *Exerciſes* upon *Joynery*, (whither I refer you) and there ſet them up, each in his proper place, according to the Draft.

The

The Draft of a Foundation I have described in *Plate* 10, according to a Scale of eight Foot in an Inch; where you have the Front A B 20 Foot long, the sides A C and B D 50 Foot long. The Shop or first Room E E 25 Foot (as aforesaid) deep. I make the first Room a Shop, because I intend to describe *Shop-windows*, *Stalls*, &c. though you may Build according to any other purpose: the *Kitching* or *Back Room* F F 15 Foot deep. A *Buttery* or *Closet* taken out of the *Yard*, marked G, 10 foot deep, and 8 foot wide. H a *Setting off* in the *Yard*, 4 foot square for the *House of Office*. I *Leaving way* in the Shop for a *Stair Case* 6 foot, and 11 foot. K the *Yard*. L the *Sink-hole* 1 foot square. M *Leaving way* in the *Kitching* 6 foot deep, and 4 foot wide for the *Chimneys*.

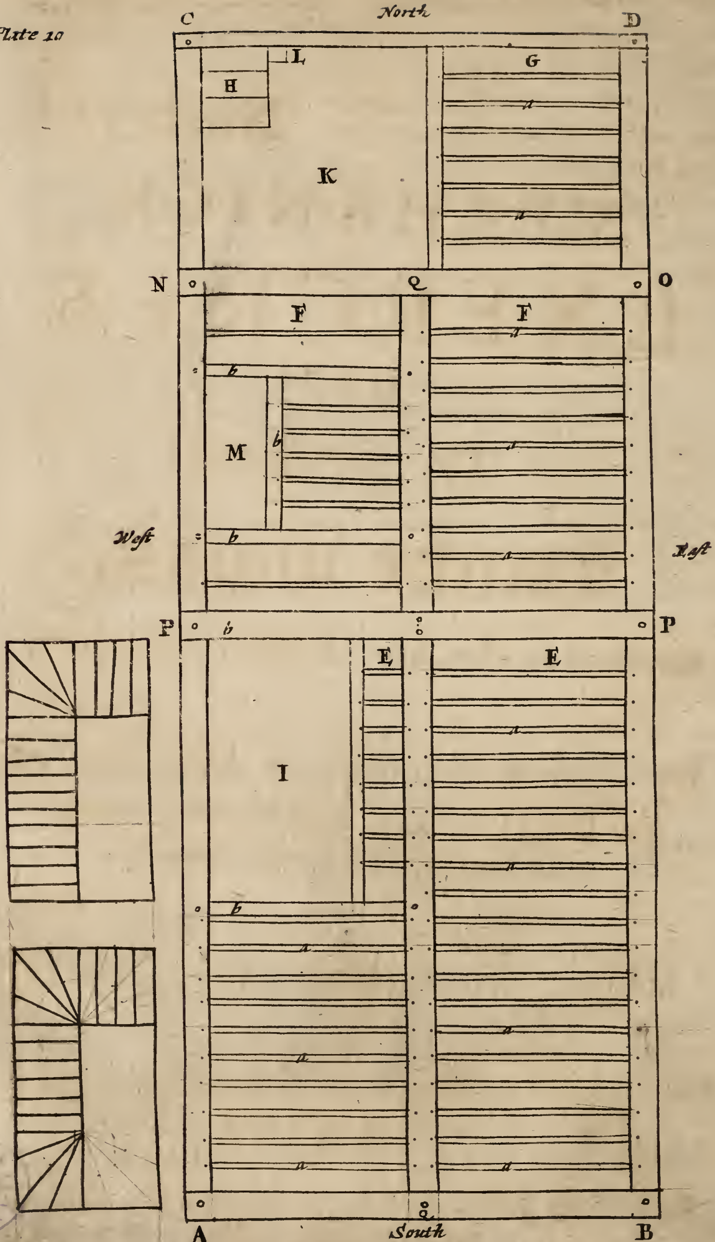
I do not deliver this Draft of Partitions for the most commodious for this Ground-plot, nor is the House set out designed for any particular Inhabitant; which is one main purpose to be considered of the Master-Workman, before he make his Draft; for a Gentlemans house must not be divided as a Shop-keepers, nor all Shop-keepers Houses alike; for some Trades require a deeper, others may dispense with a shallower Shop, and so an inconvenience may arise in both. For if the Shop be shallow, the Front Rooms upwards ought to be shallow also: because by the strict Rules of *Architecture*, all Partitions of Rooms ought to stand directly over one another: for if your Shop stand in an eminent Street, the Front Rooms are commonly more Airy than the Back Rooms; and always more commodious for observing publick Passages in the Street, and in that respect it will be inconvenient to make the Front Rooms shallow: But if you have a fair Prospect

back-

backwards of Gardens, Fields, *&c.* (which ſeldome happens in Cities) then it may be convenient to make your Back Rooms the larger for Entertainment, *&c.* But I ſhall run no further into this Argument: for I ſhall leave the Maſter workman to conſult Books of *Architecture*, and more particularly the Builder, which in this caſe they all ought to do.

*M E-*

Plate 10



Numb. VIII.

# MECHANICK EXERCISES.

OR,

The Doctrine of

# Handy-works.

Applyed to the Art of House-Carpentry.

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By *Joseph Moxon*, a Member of the Royal Society, and Hydrographer to the King's most Excellent Majesty.

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*LONDON*,

Printed for *Joseph Moxon*, at the Sign of *Atlas* on *Ludgate Hill*. 1679.

# *MECHANICK EXERCISES,*

## O R,

## The Doctrine of *Handy-works* : applied to the Art of *House-Carpentery.*

---

A C, B D, C D, N O, *Ground-plates, Wall-plates, Bressummers, Lintels, the Thickness of the Wall.*
A B, *Also a Ground-plate, or Ground-sell.*
P P, *The Summer.*
Q Q Q, *Girders.*
I, *The Well-houle for the Stairs, and Stair-case.*
M, *Leaving a way for the Chilmnies.*
*bb, Trimmers for the Chilmny way and Stair-case.*
*a a a a, Joysts.*

### § 15. *Of* Framing *for the* Floors.

THe four Plates, A B, A N, N O and B O, lying on the Foundation, are called *Ground-plates.* They are to be of good Oak, and for this size of Building about 8 Inches broad, and 6 Inches deep. They are to be framed into one another with Tennants and Mortesses. The longer Ground-plates A N and B O are commonly tennanted into the Front and Rear Ground-plates A B and N O, and into these two side-Ground-plates are Mortesses made for the Tennants at the ends of the Joysts, to be fitted somewhat loosly in, at about 10 Inches distance from one another, as in the Draft. These Ground plates are to be bor'd with

an Inch and half *Augur*, and well pinned into one another with round Oaken Pins, made tapering towards the point, and ſo ſtrong, that with the hard blows of a Mallet, they may drive ſtiff into the *Augre hole*, and keep the Tennant firmly in the Morteſs. The manner of making a Tennant and Morteſs is taught in *Exerciſe* 5. § 17. But becauſe the Stuff *Carpenters* work upon, is generally heavy Timber, and conſequently not ſo eaſily mannaged as the light Stuff Joyners work upon, therefore they do not at firſt pin their Tennants into their Morteſſes with wooden Pins, leſt they ſhould lie out of ſquare, or any other intended Poſition: but laying a *Block* or ſome other piece of Timber under the corner of the Frame-work to bear it hollow off the Foundation, or what ever elſe it lies upon, they drive *Hook Pins* (deſcribed *Plate* 8, § 6.) into the four *Augre-holes* in the corners of the Ground-plates, and one by one fit the Plates either to a ſquare, or any other intended Poſition: and when it is ſo fitted, they draw out their *Hook Pins*, and drive in the Wooden Pins (as aforeſaid) and taking away the wooden *Blocks* one by one from under the corners of rhe Frame, they let it fall into its place.

But before they pin up the Frame of Ground-plates, they muſt fit in the *Summer* marked P P, and the *Girders* Q Q and all the *Joiſts* marked *a a a a* &c. and the *Trimmers* for the *Stair-caſe*, and *Chilmney way* marked *b b*, and the binding *Joiſts* marked *c c*, for elſe you cannot ger their Tennants into their reſpective Morteſs holes. But they do I ſay fit all theſe in while the frame of Ground-plates lies looſe, and may corner by corner be opened to let the reſpective Tennants into their reſpective Morteſſes, which when all

all is done, they frame the *Raiſing-plates* juſt as the *Ground-plates* are framed; and then frame the Roof into the *Raiſing-plates* with *Beams*, *Joyſts*, &c.

The *Summer* is in this Ground-plate placed at 25 foot diſtance from the Front, and is to be of the ſame ſcantlin the principal Plates are of, for Reaſons as ſhall be ſhewn hereafter: and the *Girders* are alſo to be of the ſame Scantlins the *Summer* and *Ground-Plates* are of, though according to the nice Rules of *Architecture*, the *Back-Girder* need not be ſo ſtrong as the *Front-Girder*, becauſe it Bears but at 14 foot length, and the *Front-Girder* Bears at 24 foot length: yet Carpenters (for uniformity) generally make them ſo, unleſs they build an Houſe by the great, and are agreed for the Sum of Money, *&c.*

The *Joiſts* Bearing at 8 Foot (as here they do) are to be 7 Inches deep, and 3 Inches Broad.

The *Trimmers* and *Trimming Joyſts* are 5 Inches broad and 7 Inches deep, and theſe *Joyſts*, *Trimmers* and *Trimming Joyſts*, are all to be pinned into their reſpected Morteſſes; and then its flatneſs try'd with the *Level*, as was taught § 7.

### § 16 *Of ſetting up the* Carcaſs.

Though the *Ground-plates*, *Girders*, &c. be part of the *Carcaſs*, yet I thought fit in the laſt Section they ſhould be laid, before I treated of the ſuperſtructure, which I ſhall now handle. The four *Corner Poſts* called the *Principal Poſts* marked A A, ſhould be each of one piece, ſo long as to reach up to the *Beam* of the *Roof*, or *Raiſing-Plate*, and of the ſame Scantlin the *Ground Plates* are of, *viz.* 8 Inches broad, and 6 Inches thick, and ſet with one of its

narroweſt ſides towards the Front. Its lower end is to be Tennanted, and let it into a Morteſs made near the corner of the *Ground Plate* Frame; and its upper end hath alſo a Tennant on it, to fit into a Morteſs made in the Beam of the Roof or *Raiſing piece.*

At the heighth of the firſt ſtory in this Principal Poſt, muſt be made two Morteſſes, one to receive the Tennant at the end of the Breſummer that lies in the Front, and the other to entertain the Tennant at the end of the Breſſummer that lies in the Return ſide.

Two ſuch Morteſſes muſt alſo be made in this Principal Poſt at the heigth of the ſecond Story, to receive the Tennants at the ends of the Breſſummers for that Story.

Though I have ſpoken ſingularly of one *Principal Poſt*, yet as you work this, you muſt work all four *Principal Poſts*; and then ſet them plumb upright, which you muſt try with a Plumb-line deſcribed in *Plate* 8 §.

Having erected the *Principal Poſts* upright, you muſt enter the Tennants of the Breſſummers into their proper Morteſſes, and with a Nail or two (about a ſingle Ten or a double Ten) tack one end of a deal Boad, or ſome other light piece of ſtuff to the Breſſummer, and the other end to the fram'd work of the Floor, to keep the *Principal Poſts* upright, and in their places. Then ſet up the ſeveral Poſts between the *Principal Poſts*; but theſe Poſts muſt be Tenanted at each end, becauſe they are to be no longer than to reach from Story to Story, or from Entertiſe to Entertiſe, and are to be framed into the upper and under Breſſummer. If the Entertiſes be not long enough, they ſet up a Principal Poſt between

tween two or three lengths, to reach from the Ground plate up to the Raiſing plates.

It is to be remembred, that the Breſſummers and Girders are laid flat upon one of their broadeſt ſides, with their two narroweſt ſides perpendicular to the Ground-Plot; but the Joyſts are to be laid contrary: for they are framed ſo as to lie with one of their narroweſt ſides upwards, with their two broadeſt ſides perpendicular to the Ground-Plot. The reaſon is, becauſe the Stuff of the Breſſummers and Girders are leſs weakned by cutting the Morteſſes in them in this poſition, than in the other poſition; for as the Tennants for thoſe Morteſſes are cut between the top and bottom ſides, and the flat of the Tennants are no broader than the flat of the narroweſt ſide of the Joyſts; ſo the Morteſſes they are to fit into, need be no broader than the breadth of the Tennant, and the Tennants are not to be above an inch thick, and conſequently the Morteſſes are to be made with an Inch Morteſs-Chiſſel, as was ſhewn Numb. 5. § 17. for great care muſt be taken that the Breſſummers and Girders be not weakned more than needs, leaſt the whole Floor dance.

Theſe Tennants are cut through the two narroweſt ſides, rather than between the two broadeſt ſides, becauſe the ſtuff of the Girders retains more ſtrength when leaſt of the Grain of the ſtuff is cut: And the Tennants being made between the narroweſt ſides of the Joyces, require their Morteſs-holes no longer than the breadth of that Tennant: And that Tennant being but an Inch thick, requires its Morteſs but an Inch wide to receive it; ſo that you Morteſs into the Girder no more than three Inches wide with the Grain of the Stuff, and one Inch broad contrary

to

to the Grain of the Stuff. But ſhould the Tennant be cut between the two broad ſides of the Joyſts, the Morteſs would be three Inches long, and but one Inch broad, and conſequently, you muſt cut into the Girder three Inches croſs the Grain of the Stuff, which would weaken it more than cutting ſix Inches with the Grain and one Inch croſs.

But it may be objected that the Tennants of the Joyſts being ſo ſmall, and bearing at an Inch thickneſs muſt needs be too weak.

Anſwer, firſt, though the Tennants be indeed but an inch thick,and three Inches broad; yet the whole Bearing of the Joyces do not ſolely depend upon their Tennants; becauſe the Girders they are framed into,prove commonly ſomewhat Wainny upon their upper ſides, and the Joyſts are always ſcribed to project over that Waynnineſs, and ſo ſtrengthen their Bearing by ſo much as they project over the roundneſs or wayninneſs of the upper ſide of the Girder.

Secondly, the Floor is boarded with the length of the Boards athwart the Joyſts, and theſe Boards firmy railed down to the Joyſts, which alſo adds great ſtrength to them.

Thirdly, The Joyſts are ſeldome made to Bear at above ten foot in length, and ſhould by the Rule of good workmanſhip not lie above ten Inches aſunder at the moſt: ſo that this ſhort Bearing and cloſe diſcharging of one another, renders the whole floor firm enough for all common occupation. But if the Joyces do bear at above ten foot in length, it ought to be the care of the Maſter Workman to provide ſtronger ſtuff for them, *viz.* Thicker and Broader. If not, they cut a Tusk on the upper ſide of the Tennant, and let that Tusk into the upper ſide of the Girders.

Ha-

Having erected the Principal Poſt,and other Poſts, and fitted in the Breſſummers, Girders, Joyſts, *&c.* upon the firſt Floor, they pin up all the Frame of Carcaſs-work. But though the Girders and Joyſts deſcribed for this firſt floor, lie proper enough for it; yet for the ſecond ſtory, and in this particular caſe, the Joyſts lie not proper for the ſecond ſtory; becauſe in the ſecond ſtory we have deſcribed a *Balcony.*

Therefore in this caſe you muſt frame the Front-Breſſumer about ſeven Inches lower into the Principal Poſts: Becauſe the Joyſts for the ſecond Floor are not to be Morteſſed into the Breſſummer to lie even at the top with it, but muſt lie upon the Breſſummer, and project over it ſo far as you deſign the *Balcony* to project beyond the Upright of the Front: And thus laying the Joyſts upon the Breſſummer renders them much ſtronger to bear the *Balcony*, than if Joyſts were Tennanted into the Front of the Breſſummer, and ſo project out into the Street from it.

But the truth is, Though I have given you a Draft of the Joyſts lying athwart the Front and Rear for the firſt Floor, you may as well lay them Range with the two ſides on the firſt Floor. But then the Breſſummer that reaches from Front to Rear in the middle of the Floor muſt be ſtronger: And Girders muſt then be Tennanted into the Breſſummer, and the Ground-plates at ſuch a diſtance, that the Joyſts may not Bear at above ten Foot in length. And the Tennants of the Joyſts muſt be tennanted into the Girders, ſo that they will then lye Range with the two Sides.

But, a word more of the Breſſummer: I ſay (as before) the Breſſummer to Bear at ſo great length muſt be

be ſtronger, though it ſhould be diſcharged at the length of the Shop, (*viz.* at 25 Foot) with a Brick Wall, or a Foundation brought up of Brick. But if it ſhall have no Diſcharge of Brick-work, but Bear at the whole 40 Foot in length, your Breſſummer muſt be yet conſiderably ſtronger than it need be, were it to Bear but 25 Foot in length; becauſe the ſhorter all the Bearings of Timbers are, the firmer they Bear. But then the Framing work will take up more labour: And in many caſes it is cheaper to put in ſtronger ſtuff for long Bearings, than to put a Girder between to Diſcharge the length of the Joyſts to be framed into the Girders.

But to make ſhort of this Argument, I ſhall give you the Scheme of Scantlins of Timbers at ſeveral Bearings for *Summers*, *Girders*, *Joyſts*, *Rafters*, *&c.* as they are ſet down in the Act of Parliament for the rebuilding the City of *London*, after the late dreadful Fire: which Scantlins were well conſulted by able Workmen before they were reduced into an Act.

*Scantlings of Timber for the firſt ſort of Houſes.*

| | | *Foot* | *Inches* | | *Inches* |
|---|---|---|---|---|---|
| For the Floor | Summers under | 15 | 12 | and | 8 |
| | Wall-plates | | 7 | and | 5 |

| | | *Foot* | | | |
|---|---|---|---|---|---|
| For the Roof | Principal Rafters under | 15 | at foot | 8 | 6 Inches |
| | | | at top | 5 | |
| | Single Rafters | | 4 | and | 3 Inches |

| | *Length Foot* | *Thickneſs* | | *Depth* |
|---|---|---|---|---|
| Joyſts to | 10 | 3 | and | 7 Inches |
| Garret floors | 3 | | | 6 |

*Scant-*

## *Scantlings of Timber for the other two sorts of Houses.*

**For the Floor**

| | Foot | | Foot | Breadth Inches | Depth Inches | | Thickness Inches | Depth Inches |
|---|---|---|---|---|---|---|---|---|
| Summers or Girders which bear in length from | 10 | to | 15 | 11 | and 8 | Joysts which bear 10 foot | 3 | 6 |
| | 15 | | 18 | 13 | 9 | | 3 | 7 |
| | 18 | | 21 | 14 | 10 | | 3 | 7 |
| | 21 | | 24 | 16 | 12 | | 3 | 8 |
| | 24 | | 26 | 17 | 14 | | 3 | 8 |

| | Inches | Inches |
|---|---|---|
| Principal Discharges upon Peers in the first Story in the Fronts | 13 and | 12 |
| | 15 | 13 |

Binding Joysts with their Trimming Joysts: Thickness Inches 5 — depth equal to their own floors

| | Inches | Inches |
|---|---|---|
| Wall-plates, or Raising Pieces and Beams | 10 and | 6 |
| | 8 | 6 |
| | 7 | 5 |

| Lintels of Oak in the | Inches | Inches |
|---|---|---|
| 1st. and 2d. Story | 8 and | 6 |
| 3d. Story | 5 | 4 |

**For the Roof**

| | Length Foot | Foot | | Inches | Thickness Inches |
|---|---|---|---|---|---|
| Principal Rafters from | 15 to | 18 | at foot | 9 | 7 |
| | | | at top | 7 | |
| | 18 | 21 | at foot | 10 | 8 |
| | | | at top | 8 | |
| | 21 | 24 | at foot | 12 | $8\frac{1}{2}$ |
| | | | at top | 9 | |
| | 24 | 26 | at foot | 13 | 9 |
| | | | at top | 9 | |

| | Length Foot | Foot | Inches | Inches |
|---|---|---|---|---|
| Purlines from | 15 to | 18 | 9 | 8 |
| | 18 | 21 | 12 | 9 |

| Single Rafters | Foot | Inches | Inches |
|---|---|---|---|
| not exceeding in length | 5 | 5 | 4 |
| not exceeding in length | 6 | 4 | $3\frac{1}{2}$ |

*Scantlings for Sawed Timber and Laths, usually brought out of the West Countrey, not less than*

| | Foot | *Breadth* Inches | *Thickness* Inches |
|---|---|---|---|
| Single Quarters in length | 8 | $3\frac{1}{2}$ | $1\frac{3}{4}$ |
| Double Quarters in length | 8 | 4 | $3\frac{1}{2}$ |
| Sawed Joysts in length | 8 | 6 | 4 |
| Laths in length | 5 / 4 | $1\frac{1}{4}$ | 1 quarter and $\frac{1}{2}$ Inch |

| Stone Where Stone is used, to keep to these Scantlins— | | | |
|---|---|---|---|
| | | | *Inches* |
| First sort of Houses | Corner Peers | | 18 square |
| | Middle or single Peers | | 14 and 12 |
| | Double Peers between House and House | | 14 and 18 |
| | Door-Jambs and Heads | | 12 and 8 |
| | | *Foot* | *Inches* |
| 2d & 3d sorts— | Corner Peers | 2 | 6 square |
| | Middle or single Peers | | 18 square |
| | Double Peers between House and House | | 24 and 18 |
| | Door-Jambs and Heads | | 14 and 10 |

| | *Foot* | *Thickness* | |
|---|---|---|---|
| Scantlings for Sewers | 3 wide / 5 high | Side-walls—1 Brick $\frac{1}{2}$ / Arch—1 Bick on end | Bottom paved plain, and then 1 Brick on edge circular. |

## General Rules.

*IN every Foundation within the Ground adde one Brick in thickness to the thickness of the Wall (as in the Scheme) next above the Foundation, to be set off in three Courses equally on both sides.*

*That no Timber be laid within twelve Inches of the foreside of the Chimney Jambs : And that all Joysts on the back of any Chimney be laid with a Trimmer at six Inches distance from the Back.*

*That*

*That no Timber be laid within the Tunnel of any Chimney, upon penalty to the Workman for every default Ten Shillings, and Ten Shillings every week it continues unreformed.*

*That no Joysts or Rafters be laid at greater distances from one to the other, than twelve Inches; and no Quarters at greater distance than fourteen Inches.*

*That no Joysts bear at longer length than Ten Foot; and no single Rafters at more in length than Nine Foot.*

*That all Roofs, Window-frames, and Cellar-floors be made of Oak.*

*The Tile-pins of Oak.*

*No Summers or Girders to lie over the Head of Doors and Windows.*

*No Summer or Girder to lie less than Ten Inches into the Wall, no Joysts than Eight Inches, and to be laid in Lome.*

But yet the *Carcass* is not completed, till the *Quarters* and *Braces* between the *principal Posts* and *Posts* are fitted in; the *Window Frames* made and set up, and the *Principal Rafters, Purlins, Gables, &c.* are also fram'd and set up. The manner of their *Pitch* and Scantlins you will see in *Plate* 11. And the reasons for several *Pitches* you may find among Books of *Archi-*

*tecture.* But the names of every Member you will find in the *Alphabetical Table* at the later end of these Exercises on *Carpentery*, referred unto by Letters and Arithmetical Figures in the Plate aforesaid.

But now we will suppose the Carcass is thus finished. The Bricklayer is then to bring up the *Chilmnies*, and afterwards to *Tile* the House. And then the next work the Carpenter has to do, is to Bring up the *Stairs* and *Stair-Cases*, and afterwards to *Floor* the Rooms, and *Hang* the *Doors*, *&c.* For should he either Bring up the Stairs and Stair-Cases, or Floor the Rooms before the House is Tiled or otherwise covered, if wet Wether should happen it might injure the Stairs, Flooring, &c.

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A,

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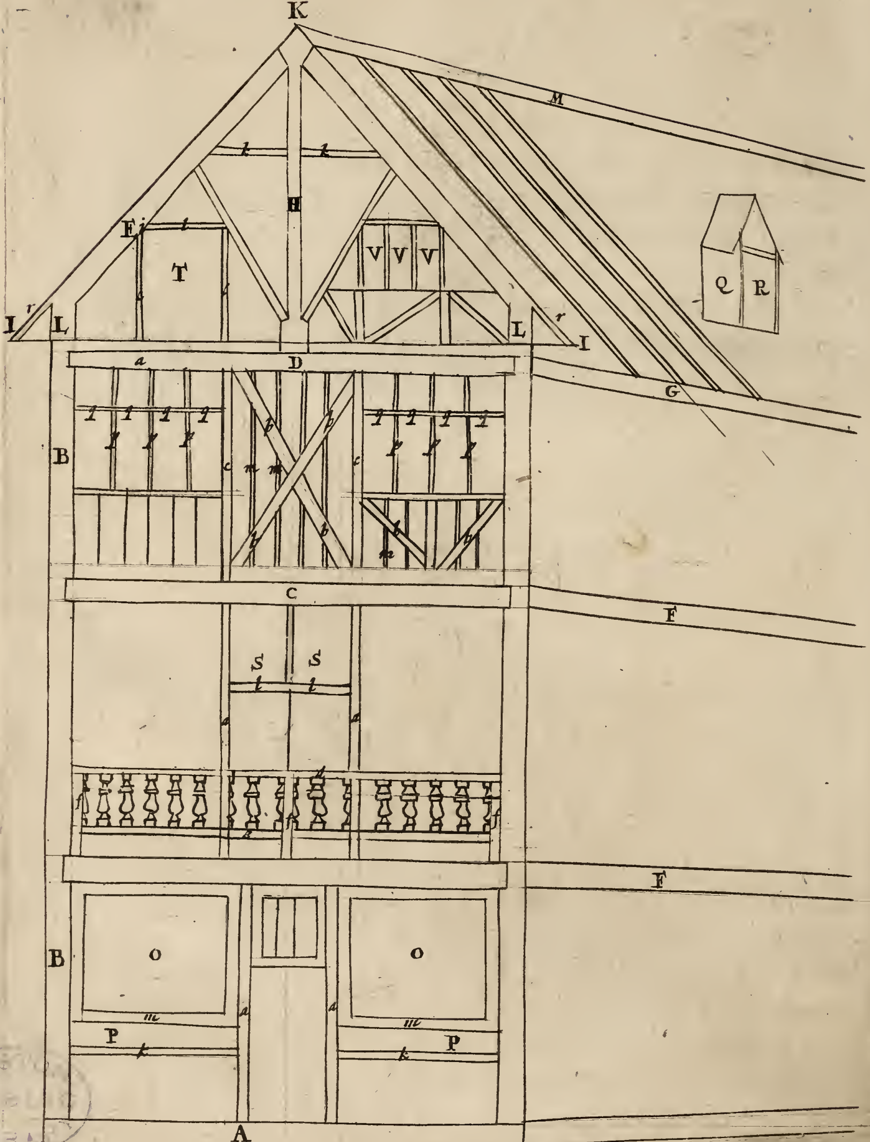
Plate 4.



A, *The Ground-plate, or Ground-ſell.*
B B, B B, *The Principal Poſts.*
C C, *The Binding Intertiſes, or indeed more properly Interduces, Breſummers, Girders.*
D, *Beam of the Roof, Breſſummer, or Girder to the Garret Floor.*
E E, *Principal Rafters.* F F, *Breſſummers.*
G, *Plate or Raiſing-piece, alſo a Beam.*
*a a, Jaums or Door-poſts.* *b b, Braces.* *c c, Jaums.*
*d, Top-rail of the Balcony.*
*e e, Bottom-rail of the Balcony.*
*fff, Poſts of the Balcony.*
*g g g, Baniſters.*
*h h, Breſſummers for the Shop-windows.*
H, *King-piece or Joggle-piece.*
*i i, Struts.*
*kk, Top-beam, Coller-beam, Wind-beam, Strut-beam.*
*l l l, Door-head.*
I I, *The Feet of the principal Rafters.*
K, *The Top of the Rafters.*
I I K, *The Gable-end.*
L L, *Knees of the Principal Rafters, to be made all of one piece with the Principal Rafters.*
M, *The Fuſt of the Houſe.*
N N, *Purlins.*
O O, *Shop-windows.*
P P, *Flaps or Falls.*
*m m m, Quarters.*
*n n, Jaums of the Window.*
*o o, Back and Head of the Window.*
*pp, Tranſums.*
*q q, Munnions.*
*r r, Furrings, or Shreadings.*
V, *Single light Windows or Luteons.*
*s s s, Rafters.*

§. 16.

## § 16. *Of* Window Frames.

IN Brick Buildings the *Window Frames* are ſo framed, that the Tennants of the Head-ſell, Ground-ſell, and Tranſum run through the outer *Jaums* about four Inches beyond them: And ſo they are ſet in a Lay of Morter upon the Brick Wall before the *Peers* on either ſide is brought up, at about three Inches within the Front: So that the Brick work over the Head and about the Jaums defend it from the weather. Then the *Bricklayer* brings up the *Peers* on both ſides, ſo that the four ends or Tennants that project through the outer Jaums being buried and *trimmed* into the Brick-work become a Faſtning to the *Window-Frame*.

But if the Window-Frame ſtands on a Timber-houſe, the Head and Groundſell are ſometimes Tennanted into the *Poſts* of the *Carcaſs*; and then the Poſts do the office of the outer Jaums of the *Window-Frame*; and the Head and Ground-ſell are then called *Entertiſes*, and therefore both Head and Ground-ſell, and *Poſts* or *Jaums*, are rabbetted about half an Inch on the outſide of the Front, to receive the Pane of Glaſs that is fitted to it. And thus (as I ſaid) the Poſts become part of the Window-Frame.

But the better way is to frame a Window as the Brick-work Window, and to project it an Inch and an half beyond the ſide of the Building, and to plaiſter againſt its ſides, for the better ſecuring the reſt of the Carcaſs from the weather.

The Window Frame hath every one of its Lights *rabbetted* on its outſide about half an Inch into the Frame

Frame, and all theſe *Rabbets*, but that on the Ground-ſell are grooved ſquare, but the *Rabbets* on the Ground-ſell is bevell'd downwards, that Rain or Snow, &c. may the freelier fall off it. Into theſe *Rabbets* the ſeveral Panes of Glaſs-work is ſet, and faſtned by the Glaſier; as ſhall be ſhewed when I come to Exerciſe upon *Glaſing*.

The ſquare Corners of the Frame next the Glaſs is Bevell'd away both on the out and inſide of the Building, that the Light may the freelier play upon the Glaſs. And upon that Bevel is commonly Stuck a Molding (for Ornament ſake) according to the fancy of the Workman, but more generally according to the various Mode of the Times.

### § 17. *Of* Stairs, *and* Stair-Caſes.

SEveral Writers of *Architecture* have delivered different Rules for the Heighth and Breadth of *Steps*, and that according to the ſeveral Capacities of the *Stair-Caſes*. They forbid more than ſix, and leſs than four Inches for the Heighth of each Step, and more than ſixteen, and leſs than twelve, for the Breadth of each Step. But here we muſt underſtand they mean theſe Meaſures ſhould be obſerved in large and ſumptuous Buildings: But we have here propoſed an ordinary private Houſe, which will admit of no ſuch Meaſures, for want of room. Therefore to our preſent purpoſe.

The firſt and ſecond Pair of Stairs the Steps ſhall be about $7\frac{1}{2}$ Inches high, and 10 Inches broad. The third Pair of Stairs each Step may be about $6\frac{1}{2}$ Inches high, and $9\frac{1}{2}$ Inches broad. And for the fourth Pair of Stairs, each Step may be about 6 Inches high, and 9 Inches

Inches broad But this Rule they do or ſhould follow, *viz.* to make all the Steps belonging to the ſame pair of Stairs of an equal heighth ; which to do, they firſt conſider the heighth of the Room in Feet and od Inches, if any od be, and multiply the Feet by 12, whoſe Product with the number of od Inches, gives the ſum of the whole Heighth in Inches ; which ſumme they divide by the number of Steps they intend to have in that Heighth, and the Quotient ſhall be the number of Inches and parts that each Step ſhall be high. Or, if they firſt deſign the Heighth of each Step in Inches, they try by Arithmetick how many times the Heighth of a Step they can have out of the whole Heighth of the Story, and ſo know the number of Steps.

Numb. IX.

# MECHANICK EXERCISES.

OR,

The Doctrine of

# Handy-works,

Applyed to the Art of House-Carpentry.

By *Joseph Moxon*, a Member of the Royal Society, and Hydrographer to the King's most Excellent Majesty.

*LONDON*,

Printed for *Joseph Moxon*, at the Sign of *Atlas* on *Ludgate Hill*. 1679.

# MECHANICK EXERCISES, O R, The Doctrine of *Handy-works*: applied to the Art of *House-Carpentery*.

STairs are either made about a *Solid Newel*, or an *Open Newel*, and sometimes mixt, *viz.* with a Solid Newel for some few Steps; then a straight or Foreright Ascent, with *Flyers* upon the side of the square Open Newel, and afterwards a Solid Newel again. Then reiterate, *&c.*

The last, *viz.* the *Mixt Newel'd Stairs*, are commonly made in our *Party-walled Houses* in *London*, where no Light can be placed in the Stair-Case, because of the Party-walls; so that there is a necessity to let in a *Sky-light* through the Hollow Newel: But this sort of Stair-Cases take up more room than those with a single solid Newel; because the Stairs of a solid Newel spread only about one small Newel, as the several Foulds of the Fans Women use spread about their Center: But these, because they sometimes wind, and sometimes fly off from that winding take therefore the more room up in the Stair-Case.

The manner of projecting them, is copiously taught in many Books of *Architecture*, whither I refer you: yet not to leave you wholly in the dark, I shall give



you

you a ſmall light into it. And firſt of the *Solid Newel.*

Winding Stairs are projected on a round *Profile*, whoſe Diameter is equal to the Baſe the Stair-Caſe is to ſtand on, ſuppoſe ſix foot ſquare. This *Profile* hath its Circumference divided into 16 equal parts. The Semi-diameter of the Profile is divided into four equal parts, and one of them uſed for the Newel, and the reſt for the length of the Steps: If you draw Lines from the Center through every one of the equal parts into the Circumference, the ſpace between every two Lines will be the true Figure of a *Winding Step.* And if they were all cut out and placed one above another over the true place on the Profile round about a Newel, whoſe Diameter is one quarter the length of a Step, you would by ſupporting each Step with a *Raiſer* have the model of a true pair of *Winding Stairs.* See Plate 10. Fig. 2.

*Hollow Newel'd* Stairs are made about a ſquare Hollow Newel. We will ſuppoſe the *Well-hole* to be eleven foot long, and ſix foot wide; and we would bring up a pair of Stairs from the firſt *Floor* eleven foot high; it being intended that a Skie-light ſhall fall through the Hollow Newel upon the Stairs: we muſt therefore conſider the width and breadth of the Hollow Newel; and in this example admit it to be two foot and a half wide, and two foot broad: by the width I mean the ſides that range with the Front and Rear of the Building, and by the breadth I mean the ſides that range with the Party-walls.

I find (by the Rule aforeſaid) that if I aſſign 18 Steps up, each Step will be ſeven Inches and one third of an Inch high.

You muſt note, that the flying off, or elſe wind-

ſorts of Stairs, and indeed all others with carving according to the Profile or Ground-plot of the Stairs are made by. But thoſe that will ſee many Inventions may conſult Books of *Architecture*, &c.

## § 18. *Of* Flooring *of* Rooms.

THough Carpenters never floor the Rooms till the Carcaſs is ſet up, and alſo incloſed by the Plaiſterer, leſt weather ſhould wrong the Flooring; yet they generally *Rough-plain* their *Boards* for Flooring before they begin any thing elſe about the Building, that they may ſet them by to ſeaſon: which thus they do, They lean them one by one on end aſlant with the edge of the Board againſt a Bauk, ſomewhat above the heighth of half the length of the Board, and ſet another Board in the ſame poſture on the other ſide the Bauk, ſo that above the Bauk they croſs one another: then on the firſt ſide they ſet another Board in that poſture, and on the ſecond ſide another, till the whole number of Boards are ſet an end: being ſet in this poſture, there remains the thickneſs of a Board between every Board all the length, but juſt where they croſs one another, for the Air to paſs through to dry and ſhrink them, againſt they have occaſion to uſe them: But they ſet them under ſome covered Shed, that the Rain or Sun comes not at them: for if the Rain wet them, inſtead of ſhrinking them, it will ſwell them; or if the Sun ſhine fiercely upon them, it will dry them ſo faſt, that the Boards will *Tear* or *Shake*, wich is in Vulgar Engliſh *Split* or *Crack*.

They have another way to dry and ſeaſon them, by

by laying them flat upon three or four Bauks, each Board about the breadth of a Board aſunder, the whole length of the Bauks. Then they lay another Lay of Boards athwart upon them, each board alſo the breadth of a Board aſunder; then another Lay athwart the laſt, till all are thus laid: ſo that in this poſition they alſo lie hollow for the Air to play between them.

Thus then, The Boards being Rough-plain'd and Seaſon'd. They try one ſide flat,as by *Numb.* 6. § 31. and both the edges ſtraight, as if they were to ſhoot a Joynt; as by *Numb.* 4. § 4. and cut the Boards to an exact length: becauſe if the Boards are not long enough to reach athwart the whole Room, the ends may all lie in a ſtraight Line, that the ſtraight ends of other Boards laid againſt them may make the truer Joynt, and this they call a *Beaking Joynt* But before they lay them upon the Floor, they try with the *Level* (deſcribed § 7.) the flatneſs of the whole Frame of Flooring again, leſt any part of it ſhould be *Caſt* ſince it was firſt framed together: and if any part of the Floor lie too high, they with the *Adz* (if the eminency be large) take it off, as was ſhewed § 2. Or if it be ſmall,with the *Jack-Plain*, in *Numb.* 4. § 2. till it lie level with the reſt of the Floor. But if any part of the Floor prove hollow, they lay a Chip or ſome ſuch thing upon that hollow place, to bear up the Board, before they nail it down.

All this being done, they chuſe a Board of the commoneſt thickneſs of the whole Pile for the firſt Board, and lay it cloſe againſt one ſide of the Room athwart the Joyſts, and ſo nail it firmly down with two Brads into every Joyſt it croſſes, each Brad a-
bout

bout an Inch, or an Inch and a half within the edge of the Board.

If they ſhould lay a more than ordinary thick or thin Board at the firſt, they would have a greater number of Boards to work to a Level than they need, becauſe all the reſt of the Boards muſt be equalized in thickneſs to the firſt.

Then they lay a ſecond Board cloſe to the firſt. But before they nail it down they again try how its ſide agrees with the ſide of the firſt, and alſo how its thickneſs agrees with the firſt Board. If any part of its edge lie hollow off the edge of the firſt Board, they ſhoot off ſo much of the length of the Board from that hollowneſs towards either end, till it comply and make a cloſe Joynt with the firſt. But if the edge ſwell in any place, they plain off that ſwelling till it comply as aforeſaid.

If the ſecond Board prove thicker than the firſt, then with the *Adz* (as aforeſaid) they hew away the underſide of that Board (moſt commonly croſs the Grain, leſt with the Grain the edge of the *Adz* ſhould ſlip too deep into the Board) in every part of it that ſhall bear upon a Joyſt, and ſo ſink it to a flat ſuperficies to comply with the firſt Board. If the Board be too thin, they underlay that Board upon every Joyſt with a Chip, &c.

And as this ſecond Board is laid, ſo are the other Boards laid, if they be well aſſured the Boards are dry and will not ſhrink: but if they doubt the drineſs of the Boards, they (ſometimes do or ſhould) take a little more pains; for after they have nailed down the firſt Board, they will meaſure the breadth of two other Boards, laying them by the ſide of the firſt. But yet they will not allow them their full

room

room to lie in, but after their edges are true ſhot in a ſtreight line, they will pinch them off about half a quarter of an Inch room more or leſs, according as they gueſs at the well-ſeaſonedneſs of the Boards; by nailing down the fourth Board nearer to the firſt Board by half a quarter of an Inch (more or leſs) than the breadth of both Boards are. And though it be afterwards ſomewhat hard to get theſe two Boards into that narrow room, *viz.* between the firſt and fourth Board, yet they help themſelves thus; The under-edges of theſe Boards that are to joyn to each other they Bevel ſomewhat away, and then the firſt and fourth Board being faſt nailed down (as aforeſaid) they ſet the outer edges of theſe two Boards againſt the two nailed Boards, letting the inner edges of the two looſe Boards meet, and make an Angle perpendicular to the Floor. Then with two or three men jumping all at once upon that Angle, theſe two Boards with this force and reiterated jumps by degrees preſs flat down into the ſuperficies of the Floor; or elſe with Forçing Pins and Wedges force them together: and then with Brads they nail them down, as they did the firſt Board. Thus afterwards they nail down a ſeventh Board as they did the fourth, and then fit in the fifth and ſixth Boards, as they did the ſecond and third Boards. And ſo on nailing down every third Board, and forcing two others between it and the laſt nailed Board, till the whole Floor be Boarded.

But if theſe Boards are not long enough (as I hinted before) to reach through the whole Room, they examine how true the ends lie in a ſtraight line with one another, by applying the edge of the Two-foot Rule to the ends and where the ends of any Boards

keep

keep off the edge of the Two-foot Rule from complying with the whole range of ends, they with the *Chissel* and *Mallet* cut off that irregularity, holding and guiding the Chissel so that it may rather cut away more of the bottom than top of the Board, that so the Boards joyned to the ends of the first laid Boards, may make on the Superficies of the Floor the finer and truer Joynt.

Having thus Boarded the whole Room, notwithstanding they used their best diligence to do it exactly, yet may the edges of some Boards lye somewhat higher than the Board it lies next to: therefore they peruse the whole Floor, and where they find any irregularities they plane them off with the Plane, *&c.*

### § 19. *The* Hanging *of* Doors, Windows, *&c.*

THE Floors being Boarded, the next work is to *Hang* the *Doors*, in which though there be little difficulty, yet is there much care to be taken, that the Door open and shut well.

If the Door have a *Door-Case* (as Chamber-Doors, and Closet-Doors commonly have) the *Jaums* of the Door Case must stand exactly perpendicular, which you must try by the Plumb-line. as by § 8. and the Head of the Door Case or Entertise must be fitted exactly square to the J*aums*, as you were taught *Numb.* 5. § 17, 18, 19. and the Angles of the Door must be made exactly square, and the *Rabbets* of the Door to fit exactly into the Rabbets of the Door-Case. But yet they commonly make the Door about one quarter of an inch shorter than the insides of the Jaums of the Door-Case, lest if the Boards of the Floor chance to swell within the sweep of the Door, the bottom

of the Door ſhould drag upon the Floor.

They conſider what ſort of Hindges are properest for the Door they are to *Hang*. When they have a *Street-door* (which commonly is to take off and lift on ) they uſe *Hooks* and *Hindges*. In a Battend-door, Back-door, or other Battend-door, or Shop-windows, they uſe *Croſs-Garnets*. If a *Fram'd Door*, *Side Hinges*: And for *Cup-board Doors* and ſuch like, Duf-Tails. (See the deſcription of theſe Hindges in *Numb.* 2. *Fig.* 1.5,6.) But what ſort of Hindges ſoever they uſe, they have care to provide them of a ſtrength proportionable to the ſize and weight of the Door they hang with them. Well-made Hindges I have deſcibed *Numb.*2.*fol.*20. Whither to avoid repetition I refer you.

If they Hang a Street-door ( which is commonly about ſix foot high ) they firſt drive the Hooks into the *Door-Poſt*, by entring the Poſt firſt with an *Augure*: But the *Bit* of the *Augure*, muſt be leſs than the Shank of the Hook, and the hole boared not ſo long, becauſe the Shank of the Hook muſt be ſtrongly forced into the Augure-hole, and ſhould the Augure-hole be too wide, the Shank would be looſe in it, and not ſtick ſtrong enough in it. Therefore if the Shank be an Inch ſquare, an half-Inch-Augure is big enough to bore that hole with, becauſe it will then endure the heavier blows of an Hammer, to drive it ſo far as it muſt go; and the ſtronger it is forced in, the faſter the Hook ſticks. But yet they are careful not to ſplit the Door-Poſt.

Theſe Hooks are commonly drove in about Fifteen Inches and an half above the *Ground-ſell*, and as much below the top of the Door. It is or ſhould be their care to chuſe the Pin of the lower Hook

ing of theſe Steps will vary their places according as you deſign the firſt Aſcent. For if you make the firſt Aſcent as you come ſtraight out of the Street (as in Plate 10.) on the South ſide, you will firſt aſcend upon a Pitch of *Flyers*, which Pitch (making an Angle of 38 deg. with the Floor) with ten Steps raiſe you ſix Foot high above the Floor, and bring you eight Foot towards the *North* end of the *Well-hole*, by making each Step ten Inches broad.

But now you muſt leave *Flyers*, and make four Winding Steps. Theſe Winding ſteps are made about a ſolid *Newel* (as hath been taught) and this *Newel* ſerves alſo for a *Poſt* to *Trim* the *Stair-Caſe* too. This Poſt ſtands upon the Floor, and is prolonged upwards ſo high, that Morteſſes made in it may receive the Tennants of the *Top* and *Bottom Rails* of the whole Stair-caſe for that Floor: theſe four Winding ſteps aforeſaid, rounding one quarter about the Newel, turns your Face in your Aſcent now towards the *Eaſt*: theſe four ſteps are raiſed 2 foot, $5\frac{1}{3}$ Inches above the Flyers, ſo that (in all) your Stairs are now raiſed 8 foot $6\frac{2}{3}$ Inches. Here remains now only 2 foot $5\frac{1}{3}$ Inches to the *Landing place*, and theſe take up juſt four Flyers, which muſt be made as was taught before.

But now in your ſecond pair of Stairs it will be proper to begin your Aſcent with your Face towards the *Weſt*: for landing by the firſt pair of Stairs with your Face towards the *Eaſt*, you turn by the ſide of the Rail on the ſecond Floor from the *Eaſt* towards the *North*, and at the further end of that Rail you turn your Face again from the *North* towards the *Weſt*, and begin your Aſcent on the ſecond pair of Stairs.

Between the Skie-light and the Aſcent is a Poſt ſet upright to faſten Rails into: (to bound the Stair-caſe) from the bottom of which, *viz.* on the ſecond Floor you trim up three Flyers, and then turn off a quarter of a Circle; with Winding ſteps: then again, Flyers to your deſigned pitch: and then again another quarter of a Circle with winding ſteps, *&c.*

The Rail theſe Steps are built upon, being at the beginning or bottom of the Aſcent framed or otherwiſe faſtned to the firſt upright Poſt, muſt at its higher end be framed into the next Poſt alſo, with a Bevel Tennant, as you were taught to frame *Quarters* into one another, *Numb.* 5. § 17. Only with this difference, that there you were taught to frame Square; But here you muſt frame upon the *Bevel*, as you were taught, *Numb.* 5. § 19. This Poſt aforeſaid Bears upon the Floor, to make its Bearing the ſtronger; and this Poſt muſt be continued to ſuch an heighth, as it may alſo ſerve to receive the Tennanted end of an upper and lower Rail framed into it. And between theſe *Bevelling Rails Banniſters* make good the outſide of the *Stair-Caſe.*

Though I have here deſcribed this Contrivance of a pair of Stairs, yet do I not deliver it as the beſt Patern for this Building, or for theſe ſorts of Stairs, nor matters it to our purpoſe whether it be or no; for (as I told you before) my undertaking is the *Doctrine of Handy-works*, not *Architecture*; but 'tis *Architecture* conſiders the beſt forming of all Members in a Building for the capacitie of the Ground-Plot, and the Convenience of the intended Inhabitant; but Carpenters (as Carpenters) only work by directions preſcribed by the Architect.

Theſe therefore are the common Rules that theſe

Hook about a quarter of an Inch longer than that they uſe for the upper Hook ( or elſe to make it ſo) becauſe theſe Doors are commonly un-weildy to lift off and on, eſpecially to lift both the Hindges on both the Hooks at once. Therefore when the lower Hindge is lifted on the lower Hook, if the Door be then lifted perpendicularly upright, ſo high as the under ſide of the upper Hindge may juſt reach the top of the upper Hook, you may the eaſier ſlip the Eye of the upper Hindge upon the Hook; whereas, if the lower Hook be either ſhorter, or juſt no longer than the other; inſtead of lifting it readily upon the upper Hook, you may lift it off the lower Hook, and ſo begin the labour again.

Having drove in the Hooks they ſet the *Rabbits* of the Door within the *Rabbits* of the Door Poſts, and underlay the bottom of the Door, with a Chip or two about half a quarter of an Inch thick, to raiſe the Door that it Drag not. Then they put the Eyes of the Hindges over the Pins of the Hooks, and placing the Tail piece of the Hindges parallel to the bottom and top of the Door, they ſo nail them upon.

This is the Rule they generally obſerve for Hanging Doors, Shop-windows, *&c.* Only, ſometimes inſtead of Nailing the Hindges upon the Door, they *Rivet* them on, for more ſtrength, And then, after they have fitted the Door or Window into its Rabbits, and laid the Hindges in their proper place and poſition (as aforeſaid) they make marks in the Nail-holes of the Hindge with the point of their Compaſſes upon the Door, and at thoſe marks they Pierce-holes, with a *Piercer-Bit*, that fits the ſhank of the *Rivet* ; then they put the ſhank of the

*Rivet* through the holes made in the Door; yet ſo that the Head of the Rivet be on the outſide of the Door; and they alſo put the end of the Shank into the Nail-hole of the Hindge, and ſo while another man holds the Head of the Hatchet againſt the Head of the Rivet, they with the *Pen* of their *Hammer* batter and ſpread the flat end of the Shank over the Hole, as was ſhewn. Numb. 2. fol. 24, 25.

The Titles of ſome Books of Architecture.

*Sebaſtion Seirlio*, in Folio.
*Hans Bloom's* Five Collumns, Folio.
*Vignola*, in Folio.
*Vignola*, Or the *Compleat Architect*, in Octavo
*Scamotzi*, Quarto.
*Palladio*, Quarto.
Sir *Henry Wotton*'s Elements of Architecture, Quarto.

Theſe Books are all Printed in Engliſh: But there are many others extant in ſeveral other Languages, of which *Vitruvius* is the chief: For from his Book the reſt are generally derived; as *Philip Le Orm*, *Ditterlin*, *Marlois*, and many others, which being difficult to be had among Book-ſellers, and theſe ſufficient for information, I ſhall omit till another opportunity.

An

An *Explanation* of *Terms* uſed in *Carpentery.*

A.

A*Dz*, Plate 8. B ∮ 2.

*Arch*, Any work wrought Circular, as the top part of ſome Window-frames, the top of ſome great Gates, the Roof of Vaults, &c.

*Architrave*, See Numb. 6. Plate 6. 1. and Plate 6. A. ∮ 1.

*Ax*, Numb. 7. Plate 8. A.

B.

B*Ack* or *Hip molding*. The backward Hips or *Valley-Rafter* in the way of an Angle for the back part of a Building.

*Banniſter*, Numb. 8. Plate 11. *g g g*.

*Baſe* is commonly the Bottom of a Collumn. See Numb. 6. Plate 6. *h*. and Plate 7. B.

*Batement*, To abate or waſte a piece of Stuff, by forming of it to a deſigned purpoſe. Thus inſtead of asking how much was cut off ſuch a piece of Stuff, Carpenters ask what *Batement* that piece of Stuff had.

*Batter*, the ſide or part of the ſide of a Wall, or any Timber that bulges from its bottom or foundation, is ſaid to *Batter* or *hang over* the Foundation.

*Battlement*, A flat Roof or Platform to walk on. But Battlements are more properly Walls built about the Platform to incloſe it, as is ſeen upon Towers for defence: Part of the Battlement being

Breaſt high that Muſquetiers may ſhoot over it, the other part Man-high, to ſecure Men from the ſhot of their enemies.

*Bauk*, a peece of Fir unſlit, from four to ten Inches ſquare: and of many lengths.

*Bear*, Timber is ſaid to *Bear* at its whole length when neither a Brick wall or Poſts &c. ſtand between the ends of it. But if either a Brick wall or Poſts, &c. be Trimmed up to that Timber, then it is ſaid to Bear only at the diſtance between the Brick-wall or Poſt and either end of the Timber. Thus Carpenters ask what

*Bearing* ſuch a peece of Timber has? the anſwer is 10, 12, 15, &c. Foot, according to the length of the whole Timber, or elſe according to the diſtance between either end of the Timber, and a

*Bearer*, *viz.* a Poſt or Brick-wall that is Trimmed up between the two ends of a peece of Timber, to ſhorten its *Bearing*.

*Bond*, when workmen ſay make good Bond, they mean faſten the two or more peeces of Timber well together, either with Tennanting and Morteſſing, or Duff-tailing, &c.

*Binding Joyſts*, See Trimmers, or Plate 10. *b b b*.

*Brace*, See Plate 11. *b b b*.

*Brad*, is a Nail to Floor Rooms with, they are about the ſize of a Ten-penny Nail, but have not their heads made with a ſhoulder over their ſhank, as other Nails, but are made pretty thick towards the upper end, that the very top of it may be driven into, and buried in the Board they nail down, ſo that the tops of theſe Brads will not catch (as the Heads of Nails would) the Thrums of the Mops when the Floor is waſhing. You may ſee them at moſt Ironmongers.

*Break*

*Break in*, Carpenters with their Ripping Chiſſel do often *Break in* to Brick-walls: that is, they cut holes, but indeed more properly break the Bricks by force, and make their hole to their ſize and form.

*Breſummer*, See Plate 11. C C, D, F F, *h h.*

*Bring up*, A term moſt uſed among Carpenters, when they diſcourſe *Bricklayers*; and then they ſay, *Bring up* the Foundation ſo high, *Bring up* ſuch a wall, *Bring up* the Chimnies, &c. which is as much as to ſay, Build the Foundation ſo high, Build the wall; Build the Chimnies, &c.

*Butment*, The peece of Ground in the yard marked, G in Plate 10. is a *Butment* from the reſt of the Ground-Plot.

*Buttreſs*, that ſtands on the outſide a wall to ſupport it.

## C

C*Amber*, A peece of Timber cut Arching, ſo as when a weight conſiderable, ſhall be ſet upon it, it may in length of time be reduced to a ſtraight.

*Cantilevers*, Peeces of Wood framed into the Front or other ſides of an Houſe to ſuſtain the Molding and Eaves over it.

*Carcaſs*, is (as it were) the Skelleton of an Houſe, before it is Lath'd and Plaiſtered.

*Cartouſes*, Ornamented *Corbels.*

*Cleer Story Window*, Windows that have no Tranſum in them.

*Commander*, See Numb. 7 Plate 8. K and § 10.

*Coping over* is a ſort of hanging over, but not ſquare to its upright, but Bevelling on its under ſide, till it end in an edge.

*Corbel,*

*Corbel*, A peece of Timber ſet under another peece of Timber, to diſcharge its Bearing.

*Crab*, The Engine deſcribed Plate 9. E. and B C D ſeveral of its Appurtenances, *viz.* B C C *Snatch Blocks.* D *Levers.* Its Office is to draw heavy Timber to a conſiderable heighth.

*Crow*, See Plate 8. L. Its Office is to remove heavy Timber, and therefore for ſtrength is made of Iron.

*Crown Poſt*, See Plate 11.H. Alſo the *King Peece*, or *Joggle peece.*

## D

DIſcharge, A Brick-wall or a Poſt trim'd up to a peece of Timber over charg'd for its Bearing, is a Diſcharge to that Bearing.

*Dormer*, Plate 11. Q R.

*Double Quarter*, See *Quarter.*

*Draft*, The Picture of an intended Building diſcribed on Paper, whereon is laid down the deviſed Deviſions and Partitions of every Room in its due proportion to the whole Building, See Numb. 7. § 13.

*Drag*, A Door is ſaid to *Drag* when either by its ill Hanging on its Hinges, or by the ill Boarding of the Room, the bottom edge of the Door rides (in its ſweep) upon the Floor. See § 19.

*Dragon beams* are two ſtrong Braces or Struts that ſtands under a Breſſummer, meeting in an angle upon the ſhoulder of the *King peece.* In Plate 11 *i i* are *Dragon beams.*

*Draw knife*, deſcribed Plate 8. E and § 5.

*Draw Pins*, deſcribed Plate 8. F and § 6.

*Drug*, deſcribed Plate 9 E and § 12.

*Enter*,

## E

E*Nter*, When Tennants are put into Morteſſes, they are ſaid to Enter the Morteſſes.

*Enterduce* or *Entertiſe* deſcribed Plate 11 C C.

## F

F*Eather-edge*, Boards or Planks that have one edge thinner than another are called *Feather edge* ſtuff.

*Fir Pole*, A ſort of ſtuff cut off the Fir tree, ſmall and long, commonly from 10 to 16 Foot. They are ſometimes uſed in ſleight Buildings, to ſerve inſteed of Bauks and Quarters.

*Flyers*, are Stairs made of an Oblong ſquare Figure, whoſe fore and backſides are parallel to each other; and ſo are their ends: the ſecond of theſe *Flyers* ſtands parrallel behind the firſt; the third behind the ſecond, and ſo are ſaid to fly off from one another.

*Floor*, In *Carpentery*, it is as well taken for the Fram'd work of Timber, as the Boarding over it.

*Foot-pace*, is a part of a paire of Stairs, whereon after four or ſix ſteps you arrive to a broad place, where you may take two or three paces before you aſcend another ſtep; thereby to eaſe the legs in aſcending the reſt of the ſteps.

*Furrings*, The making good of the Rafters Feet in the Cornice.

## G

G*Able* or *Gable end*, in Plate 11. H K.

*Gun*, The bevelling ſhoulder of a Joyſt or o-

 ther

ther Stuff: It is uſed for the Lapping of the end of a Joyſt &c. upon a Trimmer or Girder, and then the thickneſs of the ſhoulder is cut into the Trimmer alſo Bevilling upwards, that it may juſt receive that *Gain*, and ſo the Joyſt and Trmmer ly even and level upon their ſuperficies. This way of working is uſed in a Floor or Hearth.

*Girder*, deſcribed Plate 10 Q Q.

*Ground Plate*, deſcribed Plate 11 A.

*Ground Plot*, The peece of Ground a Building is to be erected upon.

## H

H*Ang over*, See *Batter*.

*Hips*, deſcribed Plate 11. E E, They are alſo called *Principal Rafters*, and *Sleepers*.

*Hook-pin* deſcribed Plate 8. F.

## I

J*Ack*, deſcribed Plate 8. M. An Engine uſed for the removing and commodious placing of great Timber.

*Jack-Plain* called ſo by Carpenters, but is indeed the ſame that Joyners call the *Fore Plain*, See Numb. 4. § 2. and Plate 4 B 1.

*Jaums*, Door Poſts are ſo called: So are the upright outer Poſts of a Window frame, See Plate 11. *a a a a*, *c c*, *n n*.

*Joggle peece*, See Plate 11. H.

*Joyſts*, See Plate 10 *a a a a*.

*Juffers*, Stuff, about 4 or 5 inches ſquare, and of ſeveral Lengths.

*King*

## K

KIng peece, See *Joggle peece.*

*Kerf*, See *Explanation of Terms* in Numb.6.

*Knee*, A peece of Timber growing angularly,or crooked, that is, a great Branch ſhooting out neer the top of the Trunk of the Tree, and is ſo cut that the Trunk and the Branch make an angle; as in Plate 11. E L; being made out of one peece of ſtuff: it is called a *Knee-peece*,or *Knee-Rafter*,

## L

*LAnding-place*, is the uppermoſt Step of a pair of Stairs, *viz.* The Floor of the Room you aſcend upon.

*Skirts*,Projecting of the Eaves.

*Level*, See Plate 8. G and § 7.

*Lever*, See Plate 9.D.

*Lintel*, In Brick-Buildings Carpenters lay a long piece of Timber over the Peers, to Trim with the Window-Frame ; as well to Bear the thickneſs of the Brick-wall above it, as to make Bond with the ſides of the Walls.

*Long-Plain*,The ſame that Joyners call a *Joynter.* See Numb.4. B 2 § 4.

*Luthern*, See *Dormer.*

## M.

*MOdillon*, See *Cantelever.*

*Molding*,Moldings are ſtuck upon the edges of ſtuff to Ornament it : As on Chimney-pieces,the

inner edges of Window-frames, Shelves, &c. See *Numb*.4.§.9.

*Munnion*, the upright Poſts that divide the ſeveral Lights in a Window-frame, are called *Munnions*. See Plate 11. *q q q*.

## N

NEwel, the upright Poſt that a pair of Winding-ſtairs are turned about.

## P

PItch, The Angle a Gable-end is ſet to, is called the *Pitch* of the Gable-end.

*Planchier*, An Ornament to which the Cornice is faſtned.

*Plate*, A piece of Timber upon which ſome conſiderable weight is framed, is called a Plate. Hence *Ground-Plate*, Plate 11.A. *Window-Plate*, &c.

*Pumb-line* deſcribed, Plate 8 H § 8.

*Poſts*, See *Principal Poſts*.

*Prick-Poſts*, Poſts that are framed into *Breſſummers*, between Principal-poſts, for the ſtrengthning of the Carcaſs.

*Principal-Poſts*, The Corner Poſts of a Carcaſs, See Plate 11. B B.

*Profile*, The ſame with *Ground-Plot*.

*Projecture*, is a jetting over the upright of a Building; Thus *Balconies* project into the Street.

*Puncheons*, Short pieces of Timber placed under ſome conſiderable weight to ſupport it.

*Pudlaies*,

*Pudlaies*, Pieces of Stuff to do the Office of Hand-Spikes.

*Purlins*, See Plate 11. N N.

Q.

QUarters are *ſingle* and *double*. *Single Quarters* are Sawen ſtuff, Two Inches thick, and Four inches broad. The *Double-Quarters* are ſawen to Four Inches ſquare.

*Quartering*, In the Front of the third Story in Plate 11. All the Work except the Principal Poſts, Jaums, and Window-frames, *viz.* The upright Trimming, and the Braces is called *Quartering*.

*Quirk*, A piece taken out of any regular Ground-plot, or Floor: For example, The whole Ground-plot A B C D. in Plate 10 is a regular Ground-plot. But if the piece K be taken out of it, K ſhall be a *Quirk*.

R.

R*After*, See Plate 11. *c c c c.*

*Rail*, Rails ſtand over and under Banniſters of *Balconies*; Stair-Caſes, &c.

*Raiſer*, is a Board ſet on edge under the Foreſide of a ſtep.

*Raiſing-piece*, Pieces that lye under the Beams upon Brick or Timber by the ſides of the Houſe.

*Relliſh*, See *Projecture*.

*Return*, Either of the adjoyning ſides of the Front of an Houſe or Ground-plot, is called a *Return-ſide*, as in Plate 10. the Front is A B, the *Return-ſides* to this Front is A C and B D,

*Ridge*,

*Ridge*, the meeting of the Rafters on both ſides the Houſe is called the *Ridge*.

*Ripping Chiſſel*, See Plate 8 D § 4.

*Roof*, The Covering of a Houſe; But the word is uſed in Carpentery for the Timber work of the Covering.

S

SCribe, See Number 6. in *Explanation of Terms*.

*Shake*, Such Stuff as is crackt either with the heat of the Sun or the droughth of the wind, is called *Shaken Stuff*.

*Shingles*, Smal peeces of wood uſed to cover Houſes with, inſteed of Tiles or Slates.

*Shreadings*, See Plate 11. the lower end of the Principal Rafters markt *r r* are called *Shreadings*, or *Furrings*.

*Sleepers*, The ſame with *Purlins*.

*Snatch-blocks*, See Plate 9 B C C.

*Socket Chiſſel*, Deſcribed Plate 8 and § 3.

*Soils* or *Sells*, are either *Ground Sells* deſcribed Plate 11. A. or *Window Sells* which are the bottom Peeces of Window Frames.

*Stair Caſe*, The incloſure of a pair of Stairs, whether it be with Walls, or with Walls and Railes and Banniſters, &c.

*Stancheons*, See *Puncheons*.

*Strut*, See *Dragon beam*.

*Summer*, In Plate 10. P P is a *Summer*, whereinto the Girders are Tennanted.

T

TEnfoot Rod, See § 13.

*Tranſom*, The Peece that is framd a-croſs a double-

ble Light Window, See Plate 11. P P.

*Trim*, When workmen fit a peece into other work, they ſay they *Trim* in a peece.

*Trimmers*, See Plate 10 *b b b b*.

*Truſs*, See *King peece*, or *Joggle peece*.

*Tusk*, A Bevel ſhoulder, made to ſtrengthen the Tennant of a Joyſt, which is let into the Girder.

V

V*Alley Rafter*, See *Back* or *Hip Molding*.

W

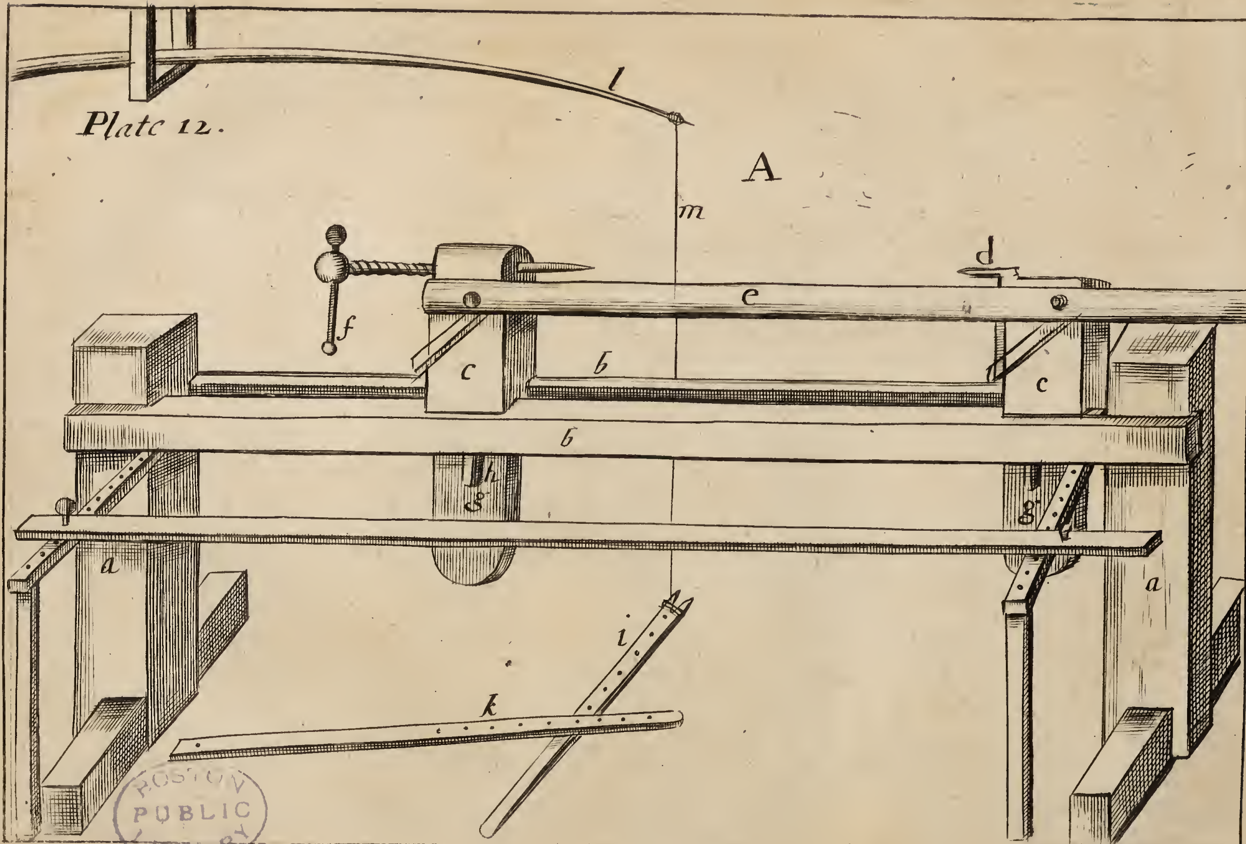
W*Ell hole*, See Plate 10. I.

*Wall Plate*, In Plate 10. A C, B D and N O are *Wall Plates*.

Thus much of *Carpentery*. The next *Exerciſes* will (God Willing) be upon the Art of *Turning*, *Soft Wood*, *Hard Wood*, *Ivory*, *Braſs*, *Iron*, &c. With ſeveral Inventions of *Oval work*, *Roſe work*, *Rake work*, *Angular work*, &c.

*FINIS.*

Plate 12.



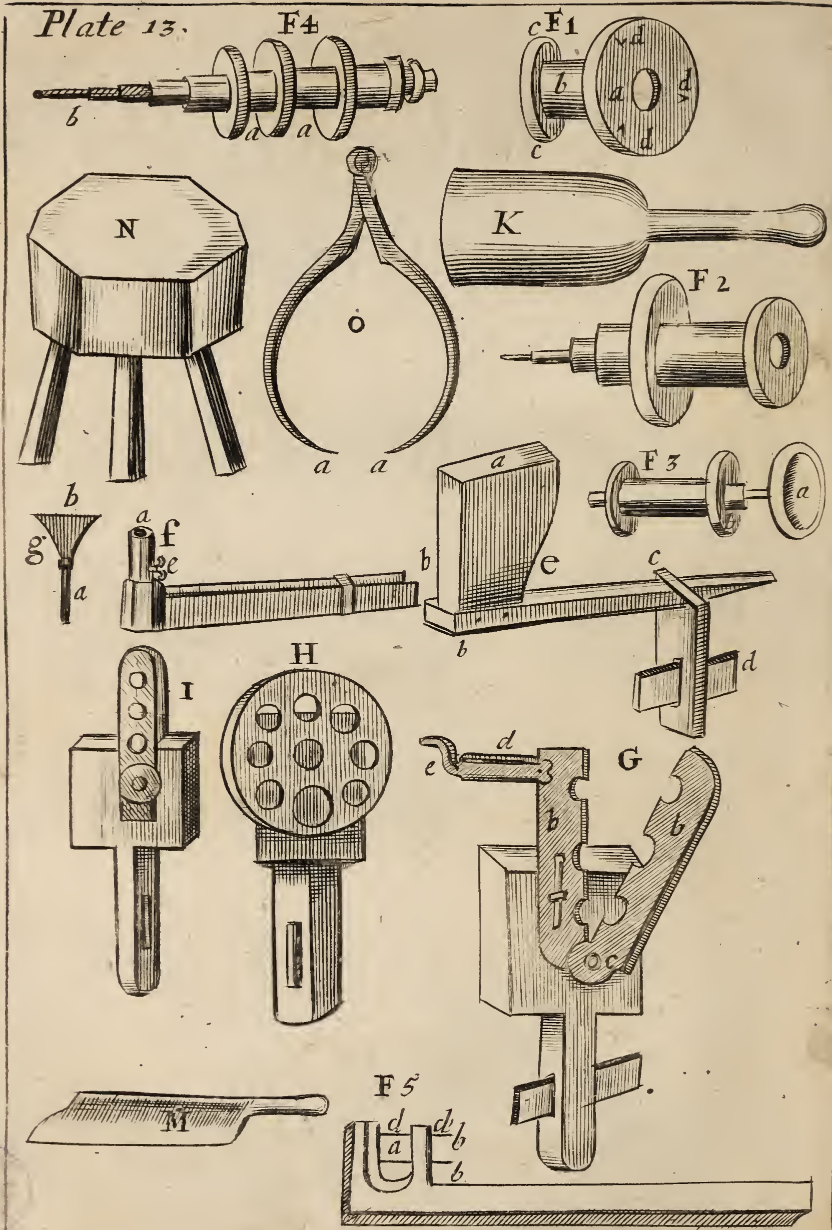


Plate 13.
F4
b
a
a
c F1
d
b
a
d
d
c
N
O
a
a
K
F 2
F 3
a
a
b
g
a
a
f
e
b
e
c
b
d
H
I
d
e
G
b
b
c
F 5
M
d
d
b
a
b
b

*Numb.* X.

# MECHANICK EXERCISES,

OR

The Doctrine of

# Handy-Works.

Applied to the Art of *TURNING*.

---

By *Joſeph Moxon*, Member of the *Royal Society*, and *Hydrographer* to the Kings moſt Excellent Majeſty.

---

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# *MECHANICK EXERCISES,*

# O R,

# The Doctrine of

# Handy-works,

# Applied to the Art of *TURNING.*

## *Of* Turning.

AS by placing one Foot of a pair of Compaſſes on a Plain, and moving about the other Foot or point, deſcribes on that Plain a Circle with the moving point; ſo any Subſtance, be it *Wood*, *Ivory*, *Braſs*, &c. pitcht ſteddy upon two points (as on an *Axis*) and moved about on that *Axis*, alſo deſcribes a Circle Concentrick to the *Axis*: And an Edg-Tool ſet ſteddy to that part of the outſide of the aforeſaid Subſtance that is neareſt the *Axis*, will in a Circumvolution of that Subſtance, cut off all the parts of Subſtance that lies farther off the *Axis*, and make the outſide of that Subſtance alſo Concentrick to the *Axis*. This is a Brief Collection, and indeed the whole Sum of *Turning*.

Now, as there is different Matter or Subſtance to be *Turned*, ſo there is alſo different Ways, and different Tools to be uſed in *Turning* each different Matter.

The different Matters are *Soft Wood*, *Hard Wood*, *Ivory*, *Braſs*, *Iron*, &c. each of which (when I have deſcribed the Turners Tools for Soft Wood) I ſhall diſcourſe upon. But,

### § I. *Of the* Lathe.

THE *Lathe* is deſcribed in *Plate* 12. A. This Machine is ſo vulgarly known, that though it cannot be deſcribed in Draft, ſo as all its parts ſhall appear at one ſingle View, yet enough of it to give you the Names of its ſeveral Members, and their Uſes are repreſented: *viz.*

*a a a a* The *Legs* or *Stiles*.
*b b* The *Cheeks* or *Sides*.
*c c* The *Puppets*.
*d* The *Screw*.
d The *Pike*.
*e* The *Reſt*.
*f* The Handle of the *Screw*.
*g* The Tennants of the *Puppets*.
*h* The *Wedge*.
*i* The *Treddle*.
*k* The *Croſs-Treddle*.
*l* The *Pole*.
*m* The *String*.
*n* The *Horn*.

### ¶ 1. *Of the* Legs, *or* Stiles.

THE *Legs* or *Stiles* are commonly about two Foot and ten Inches high, and are ſet perpendicularly upright; having each of them a Tennant on its upper end, of the thickneſs the two *Cheeks* are

to

to ſtand aſunder: And on either ſide the Shoulder of theſe two *Tennants* is laid one of the *Cheeks* cloſe to the ſides of the *Tennants*, and ſo pinned cloſe to the *Tennants* as was taught *Numb.* 5. §. 17. But a ſteddier and more ſecure way, is to have a ſtrong Iron Screw made with a ſquare Shank near the Head, that when it enters into a ſquare hole made fit to it in the hithermoſt *Cheek*, it may not twiſt about, but by the Turning about of an Iron Nut, upon the fore end of the Screw, the Nut ſhall draw the two Cheeks cloſe to the two ſides of the *Tennants*, or the upper ends of the *Legs*.

## ¶ 2. *Of the* Cheeks.

AS I told you, the Legs are to be ſet up directly perpendicular, ſo the *Cheeks* are to be faſtned directly Horizontally upon them: And the *Legs* and *Cheeks* are to be faſtned with *Braces* to the Floor and other parts of the Room the *Lathe* ſtands in, according to the convenience of the Room for faſtning, that the whole *Lathe* may ſtand as ſteddy and ſolid as may be. For if with *Turning* large Work the ſtrength of the Tread ſhould make the *Lathe* tremble, you will not be able to make true and neat Work; but the Tool will job into ſofter parts of the Stuff, and fly off where a Knot or other harder parts of the Stuff comes to the Tool.

## ¶ 3. *Of the* Puppets.

THe *Puppets* are ſquare pieces of Wood, of a Subſtance convenient to the light or heavy work they intend to *Turn*: And *Turners* will rather

have their *Puppets* too ſtrong than too weak; becauſe, though the *Puppets* be very ſtrong, yet they can turn light work with them; whereas if they be weak they cannot turn Heavy work with them: For the weight of heavy unequal tempered Stuff running about, will be apt both to ſhake the *Puppets*, and looſen the ſmall hold of the *Wedge* in the *Tennant*; by either of which Inconveniencies the Work in the *Lathe* may tremble, as aforeſaid.

And though no ſize for the heighth of the *Puppets* can be well aſſerted, becauſe of the ſeveral Diameters of Work to be *Turned*, yet Workmen generally covet to have their *Puppets* as ſhort as they well can, to bear their Work off the *Cheeks* of the *Lathe*, becauſe theſe *Puppets* ſtand the firmer, and are leſs ſubject to looſen. But then, if the Diameters of the work be large, the *Puppets* may be too ſhort to *Turn* that work in: For the P*ikes* of the P*uppets* muſt ſtand ſomewhat more than half the Diameter of the Work above the ſuperficies of the *Cheeks*. Therefore *Turners* have commonly two or three pair of P*uppets* to fit one *Lathe*, and always ſtrive to uſe the ſhorteſt they can to ſerve their Work, unleſs the ſhortneſs of the *Leggs* of the *Lathe*, makes the work fall too low for the pitch of the Workman that is to work at the *Lathe*. Therefore in the making of the *Lathe* the heighth of the *Legs* with relation to the intended work, and heighth of the Workman, are to be well conſidered.

At the lower end of theſe P*uppets* are made two *Tennants*, of ſuch a thickneſs, that they may eaſily ſlide in the *Groove* between the two *Cheeks*, and ſo long, that a *Morteſs* through it of the length of the *Cheeks* depth, and a ſufficient ſtrength of Wood below

low it may be contained. Into this *Morteſs* is fitted a Tapering-*Wedge*, ſomewhat leſs at the fore end and bigger at the hinder end than the *Morteſs*, that as it is forced into the *Morteſs* with a *Mallet* or a *Maul*, it may draw the bottom Shoulder of the *Puppet* cloſe and firmly down upon the *Cheeks*, that they may neither joggle or tremble in working.

## ¶ 4. *Of the* Horn.

UPon the Right Hand P*uppet* on the out ſide near the top of it, is hung the Tip-end of an *Horn* with its Tip downwards, to hold Oyl in, and ought to have a Wooden round *Cover* to fit into it, that neither Chips or Dirt get in to ſpoil the Oyl; and in the handle of the *Cover* ſhould be fitted a wooden *Button*, which may ſerve for an *Handle* to the C*over*: And through this *Button* ſhould be faſtned an Iron Wyer to reach almoſt to the bottom of the *Horn*: This Wyer ſtands always in the Oyl, that ſo oft as the Workman has occaſion to oyl the Centers of his Work, to make his work ſlip about the eaſier, he takes the wooden C*over* by the *Button*, Wyer and all, and with the end of the Wyer Oyls his Center-holes, and pops his Wyer and C*over* again into the *Horn* againſt he has occaſion to uſe it the next time.

## ¶ 5. *Of the* Pikes *and* Screw.

NEar the upper end of one of theſe P*uppets* is faſtned a ſtrong Iron P*ike*, but its point is made of tempered Steel; and near the upper end of the other P*uppet* is fitted an Iron *Screw* quite through a

*Nut* in the *Puppet*, whoſe point is alſo made of Temper'd Steel. This Iron *Pike* in one *Puppet*, and the *Screw* in the other *Puppet* are ſo fitted into the *Puppets*, that their Shanks lie in a ſtraight Line with one another, and both their points lie alſo in that ſtraight Line pointing to one another: And in the Head of the Iron *Screw* is a Hole where-into is fitted an Iron *Handle* about ſeven or eight Inches long, with a round *Knob* at each end of it that it ſlip not through the hole in the Head. This Iron *Handle* is to turn about the *Screw* forward or backward as your purpoſe ſhall require.

Upon the points of this *Screw* and *Pike* the Centers of the Work are pitcht, and afterwards ſcrewed with the *Screw* hard, and ſo far into the Stuff, that it may not ſlip off the points in working, eſpecially if it be ſoft Wood, and the work large and heavy.

Alſo, near the upper end of theſe *Puppets*, upon that ſide the Workman ſtands when he works, the Wood of the *Puppets* is wrought away to ſquare flat ſhoulders ſomewhat below the *Pikes*, that the *Reſt* may (if occaſion be) lie near the *Pikes*, and bear ſteddy upon the *Shoulders*.

## ¶ 6. *Of the* Reſt.

THE *Reſt* is a ſquare piece of Stuff about an Inch or an Inch and half thick, and two Inches, or two and an half broad, and ſomewhat longer than the diſtance between the *Puppets*. Its Office is to reſt the Tool upon, that it may lie in a ſteddy poſition while the Workman uſes it.

¶ 7. *Of*

## ¶ 7. *Of the* Side-Reſt.

BUT beſides this *Reſt*, *Turners* have another *Reſt*, called the *Side-Reſt*. This they uſe when they *Turn* the flat ſides of Boards; becauſe the flat ſides of Boards ſtanding athwart the *Pikes*, and this *Reſt* ſtanding alſo athwart the P*ikes*, they can the more conveniently reſt their Tool upon it. It is marked e in P*late* 13, and is in the P*late* disjunct from the *Lathe*; as well becauſe it and the Common *Reſt* cannot both together be expreſt in Picture, as alſo becauſe it is made to take off and put on as occaſion requires.

The *Reſt* is marked *a*, and is a piece of an Oaken planck or Elm plank, about two Inches thick, and ſtands ſo high above the *Cheeks* of the *Lathe* as the *points* of the P*ikes* do, or ſometimes a little higher: Its Breadth is about a Foot or more or leſs, as the Work requires, or the Workman fancies. The Bottom of it is firmly nailed to one ſide of a Quarter of Oak or Elm of about three Inches ſquare, and two Foot, or two Foot and an half long, cloſe to one end, as you ſee in the Figure at *b*, ſo as the *Reſt* ſtand upright to the piece of Quarter. This piece of Quarter is as a *Tennant* to ſlide into a ſquare Iron Collar marked *c*; This ſquare Iron Collar is made ſo long as to reach through the depth of the *Cheeks* of the *Lathe*, and to receive the Quarter or Tennant thruſt through it above the *Cheeks*, and a *Wedge* under the *Cheeks* marked *d*, which *Wedge* (when ſtiff knock'd up) draws the *Tennant* ſtrong and firmly down to the *Cheeks*, and conſequently keeps the *Side-reſt* ſteddy on any part of the *Cheeks*, according

ding as you ſlide the *Collar* forwards or backwards towards either P*ike*, or as you thruſt the *Reſt* nearer or farther to and from the *Pikes*.

Some *Turners* for ſome Work, inſtead of a plank for this *Reſt*, faſten to one end of the Quarter or *Tennant*, a long Iron with a round Cilindrick *Socket* in it, as at the Figure marked f in *Plate* 13, *a* is the *Socket* of about an Inch or an Inch and an half Diameter, to reach within two or three Inches as high as the *Pikes*, and into this *Socket* they put a long round Iron *Shank*, as in Figure g of the ſame *Plate*, *a* is the *Shank*, and at the top of this *Shank* is made the *Reſt*, marked *b*. This *Shanck* (I ſay) ſlips eaſily into the *Socket*, that it may be raiſed or let down as occaſion requires, and by the help of a *Screw* through the *Socket* at *e*, may be faſtned at that length.

The *Reſt*, (by reaſon of its round *Shank*) may be alſo turned with its upper edge more or leſs oblique or athwart the Work, or elſe parallel to the Work, according as the purpoſe may require.

Near one end of the *Reſt* is fitted and faſtned a piece of Wood about an Inch ſquare, and ten or twelve Inches long: This piece of wood is fitted ſtiff into a ſquare Hole or Morteſs made in the *Puppet*, a little above the *Shoulder* for the *Reſt*, to ſet the *Reſt* to any diſtance from the *Pikes*, which, with the ends of wooden *Screws* entred into wooden *Nuts* on the further ſide of the *Puppet*, and coming through againſt the *Reſt*, keeps the *Reſt* from being thruſt nearer to the work when the Workman is working.

¶ 8. *Of*

## ¶ 8. *Of the* Treddle *and* Crofs-Treddle.

ABout the middle between the ends, is placed a wooden *Treddle* about two Inches and an half broad, an Inch thick, and three Foot long, and fome-times three and an half, to four Foot long. The hinder end of it is faftned to the Floor, with a piece of Leather (fometimes a piece of the Upper-leather of an old Shoe, which piece of Leather is nailed to the under-fide of the hinder end of the *Treddle*, fo as to leave Leather enough beyond the end of the *Treddle* to nail down upon the Floor; which *Treddle* being thus nailed down, will move upwards, as the Spring of the *Pole* draws up the *String*; the *String* being alfo faftned to the fore-end of the *Treddle*.

The hinder end of the *Treddle* is nailed down about a Foot or a Foot and an half behind the *Lathe*, and about the middle between both the *Legs*, fo that the fore-end of the *Treddle* reaches beyond the fore-fide of the *Lathe*, about a Foot and an half or two Foot. And note, that the farther the Fore-end of the *Treddle* reaches out beyond the Fore-fide of the *Lathe*, the greater will the fweep of the Fore-end of the *Treddle* be, and confequently it will draw the more *String* down; and the more *String* comes down at one *Tread*, the more Revolutions of the Work is made at one *Tread*, and therefore it makes the greater riddance of the Work.

But then again, if the Fore-end of the *Treddle* reach too far before the Fore-fide of the *Lathe*, it may draw the end of the *Pole* fo low as to break it: and it will alfo be the harder to *Tread* down, becaufe the power commanding (which is the weight of the

*Tread)* lies ſo far from the weight to be commanded, which is the ſtrength of the P*ole*, augmented by the diſtance that the end of the *Treddle* hath from the Work in the *Lathe*; ſo that you may ſee, that the nearer the Fore-eud of the *Treddle* lies to the Perpendicular of the Work in the *Lathe*, the eaſier the *Tread* will be: And ſome *Turners* that *Turn* altogether Small Work, have the Fore-end of the *Treddle* placed juſt under their work; ſo that their S*tring* works between the *Cheeks* of the *Lathe*; But then the Sweep of the *Treddle* being ſo ſmall, the P*ole* draws up but a ſmall length of S*tring*,and conſequently makes the fewer Revolutions of the Work in one *Tread*, which hinders the riddance of the Work: unleſs with every Spring of the P*ole*, they ſhould lift their Treading Leg ſo high as to tire it quickly with bringing it down again, after it is raiſed to ſo uncommodious a poſition.

This *Treddle* hath a ſquare Notch in the middle of the further end, about an Inch and an half wide, and two Inches long, that the end of the S*tring* may be wound either off or on the Wood on either ſide the Notch, to lengthen or ſhorten the S*tring*, as the different Diameters of the Work ſhall require.

About the middle of the *Treddle* is fixed a round Iron P*in* about half an Inch in Diameter; ſo as to ſtand upright about an Inch and an half or two Inches long above the *Treddle*. And under the *Cheeks* is alſo fixed down the *Croſs-Treddle*, which is ſuch another piece of Wood as the *Treddle* is, but longer or ſhorter, according to the length of the *Lathe*: And in the middle of the Breadth of the *Croſs-Treddle* is made ſeveral holes all arow to receive the Iron P*in* ſet upright in the *Treddle*. Theſe holes are commonly

ly boared about two or three Inches aſſunder, that the Pin on the *Treddle* may be put into any one of them, according as the *String* is to be placed nearer to or further off either end of the *Lathe*.

## ¶ 9. *Of the* Pole.

THE *Pole* is commonly made of a *Fir-pole*, and is longer or ſhorter, or bigger or ſmaller, according to the weight of the Work the Workman deſigns to *Turn*: For the thicker the *Pole* is, the harder muſt the *Tread* be to bring it down; and for this reaſon, if the *Pole* prove too ſtrong for their common or continued Work, they will weaken it by cutting away (with a Draw-knife, deſcribed *Numb.* 7. *Plate* 8. E, and § 5.) part of the ſubſtance off the upper and under ſide of the *Pole*.

The thick end of this *Pole* is nailed (or indeed rather pinned) up to ſome Girder or other Timber in the Ceiling of the Room, with one ſingle Nail, or a Pin, that the *Pole* may move upon that Nail or Pin, as on a Center, and its thin end paſs from one *Puppet* to the other, as the Work may require. And at about a Foot diſtance or more, is alſo nailed up to ſome Joyſts or other Timbers of the Ceiling, two *Cheeks* of a convenient ſtrength, and at the lower end of theſe two *Cheeks* is nailed a Quarter or Batten to bear the *Pole*, though the weight of a *Tread* be added to it, as you may ſee at *n n* in *Plate* 12.

## ¶ 10. *Of the* Side-Reſt.

BUt it ſometimes happens that the Ceiling of the Work-room is not high enough for the *Pole* to

play upwards and downwards; Therefore in ſuch caſe, they place the thin end of the *Pole* at ſome conſiderable diſtance off the *Lathe*, either before or behind it, and ſo make the Spring of the *Pole* Horizontal towards the *Lathe*, conveying and guiding the *String* from the *Pole* to the Work by throwing it over a *Rowler*, moving on two Iron *Center-pins* faſtned at both ends, and placed parallel to the *Cheeks* of the *Lathe*, above the Work as high as they can; and thus every *Tread* draws the *Rowler* about: But ſhould the *Rowler* not move about upon theſe Iron *Pins*, the *String* every *Tread* would both cut a Groove in the *Ruler*, and fret it ſelf more or leſs upon the *Rowler*.

## ¶ 11. *Of the* Bow.

SOme *Turners* that work light Work, ſuch as *Cane-Heads*, *Ink-horns*, &c. for which they need ſcarce remove the *Puppets* off their *Lathe*, uſe a Common *Bow*, ſuch as Archers uſe. The middle of this *Bow* they faſten over Head, with its *String* Horizontally downwards, and in the middle of that *String* they faſten another *String* perpendicularly downwards, whoſe other end they faſten to the *Treddle*, and the *String* wound round their Work brings it about.

## ¶ 12. *Of the* Great Wheel.

BUt when *Turners* work Heavy Work, ſuch as the *Pole* and *Tread* will not command, they uſe the *Great Wheel*. This Wheel is ſo commonly known, that I ſhall need give you no other deſcription of it than the Figure it ſelf, which you may ſee in *Plate* 14. a. It is turned about with one, and ſometimes with

with two Iron *Handles*, according as the weight of the Work may require.

Its *String* hath both its ends ſtrong and neatly faſtned together, not with a Knot, but lapt over one another about three Inches in length, and ſo is firmly whipt about with ſmall Gut, that it may the eaſier paſs over the narrow *Groove* in the edge of the *Rowler*. This *String* is laid in the *Groove* made on the edge of the Wheel, and alſo in the Groove of the Work. But before it is laid upon both, one part of the *String* is lapt over and croſſes the other, and the *String* receives the Form of a Figure of 8 (only one of its Bows or Circles becomes no bigger than the *Groove* in the Work, and the other as big as the *Groove* in the *Wheele.*)

Then the whole Frame wherein the *Wheel* is fixed is removed farther off the *Lathe*, that the *String* may draw tight upon the Work.

The reaſon why the *String* thus croſſes it ſelf, is, becauſe it will touch and gird more upon the *Groove* of the Work, and conſequently (as was ſaid before ¶ 14.) will the better command the Work about.

The manner of Turning this *Wheel*, is as the manner of Turning other *Wheels* with *Handles*.

Beſides, the commanding Heavy Work about, the Wheel ridds Work faſter off than the *Pole* can do: becauſe the ſpringing up of the *Pole* makes an intermiſſion in the running about of the Work, but with the *Wheel* the Work runs always the ſame way; ſo that the Tool need never be off it, unleſs it be to examine the Work as it is doing.

When the Wheel is uſed, its Edge ſtands athwart the *Cheeks* of the *Lathe*.

## ¶ 13. *Of the* Treddle-Wheel.

THis is a *Wheel* made of a round Board of about two Foot and an half Diameter, conveniently to ſtand under the *Cheeks* of the *Lathe*. It alſo hath a *Groove* on its Edge for the *String* to run in; it hath an Iron *Axis* with a *Crook* or *Cranck* at one end: And on this *Crook* is ſlipt the Nooſe of a *Leather Thong*, which having its other end faſtned to a *Treddle*, does, by keeping exact time in *Treads*, carry it ſwiftly about without intermiſſion.

But the length of the *Thong* muſt be ſo fitted, that when the *Wheel* ſtands ſtill, and the *Crook* at the end of the *Axis* hangs downwards, the end of the *Treddle* to which the *Thong* is faſtned may hang about two or three Inches off the Ground: For then, giving the *Wheel* a ſmall turn with the Hand, till the *Crook* riſes to the higheſt, and paſſes a little beyond it; if juſt then (I ſay) the Workman gives a quick *Tread* upon the *Treddle* to bring the *Crook* down again with a jerk, that Tread will ſet it in a motion for ſeveral revolutions; and then if he obſerves to make his next *Tread* juſt when the *Crook* comes about again to the ſame poſition, it will continue the motion, and cauſe of the motion, and keep the *Wheel* always running the ſame way, if he punctually times his *Treads*.

The *Treddle Wheel* is uſed for ſmall work only, as not having ſtrength enough to carry heavy Work about, ſuch as *Cane-Heads*, *Small Boxes*, &c. and it is fitted below the *Cheeks* between the *Puppets*, as the *Bow* is above.

Beſides theſe Inventions to carry about the Work in the *Lathe*, there are many more; as with a great

*Iron*

*Iron Wheel*, having Teeth on its edge, which Teeth are to fall into an Iron *Nut* upon an Iron *Axis*, pitcht upon the P*ikes* of the P*uppets* of the *Lathe*, or fitted into *Collars*, &c.

Alſo, for very Heavy Work, as Guns, Great Mortars, *&c. Wheels* Turn'd with *Wind*, *Water* or *Horſes*, to carry the Work about. Of which more in their proper places.

## ¶ 14. *Of the* String.

UPon the thin end of the *Pole* is wound a conſiderable Bundle of *String*, That as a *Mandrel* requires to be bigger than ordinary, or the Work heavier, they may unwind ſo much of the *String* as will compaſs the *Mandrel* twice, or (if the Work be heavy) thrice; the eaſier to carry it about.

This *String* is made of the Guts of Beaſts (moſt commonly of Sheep,and ſpun round of ſeveral thickneſſes; of which the Workman chuſes ſuch ſizes as are apteſt for his Work, for large and heavy Work very thick, but for ſmall and light work thin: And there are ſeveral reaſons for his Choice; For a thin *String* will be too weak for heavy Work; but if it were not too weak for heavy work, it would be apt to mark ſoft wood more than a thick *String* would, when they are forc'd to ſhift the *String*, and let it run upon the Work. Beſides, a thin *String* (though it were ſtrong enough) would not ſo well bring heavy Work about; becauſe being ſmall, but little of the *String* touches the wood to command it, unleſs they wind it the oftner about the Work, which both takes up time, and hazards the breaking of the *String*, by the fretting of the ſeveral twiſts againſt one another.

Now

Now a thick *String* is uncommodious for ſmall work; becauſe having a ſtrength and ſtubbornneſs proportionable to its ſize, it will not comply cloſely to a piece of Work of ſmall Diameter, but will be apt to ſlip about it, unleſs both *Pole* and *Tread* be very ſtrong; and then, if the Center-holes be not very deep, and the *Pikes* fill them not very tight, and the *Puppets* alſo not very well fixt, the Strength of the *String* will alter the Center-holes; eſpecially, when the work is upon ſoft Wood, or elſe it will endanger the breaking the Woık in its weakeſt place.

### ¶ 15. *Of the* Seat.

PArallel to the *Cheeks* on the inſide the *Lathe* is fitted a *Seat*, about two and an half Inches ſquare, and the whole length of the *Lathe*; having an Iron *Pin* faſtned on either end the underſide of it: It lies upon two *Bearers* of wood, that are faſtned athwart the outer ſides the *Legs*, (or elſe to ſet it higher) the outer ends of the *Cheeks*, according to the height of the perſon that works at the *Lathe*. Theſe *Bearers* reach in length ſo far inwards, as that they may be capable to bear the *Seat* ſo far off from the *Lathe*, as is the Diameter of the Work they intend to *Turn* in the *Lathe*, and alſo the bulk of the Workman that ſtands between the *Lathe* and it, may be contained.

It is not called a *Seat* becauſe it is ſo; but becauſe the Workman places the upper part of his Buttocks againſt it, that he may ſtand the ſteddier to his Work, and conſequently guide his Foot the firmer, and exacter.

The

The two *Bearers* have ſeveral Holes made in them, from within ſixteen Inches off the *Lathe*, to the ends of them, that the Iron *Pins* faſtned in the ends of the *Seat*, may be removed nearer or farther off the *Lathe*, according to the greatneſs or ſmallneſs of the Diameter of their Work.

Having thus deſcribed the parts of a Common *Lathe*, I ſhall now follow with their other Tools alſo.

## § II. *Of* Gouges,

GOuges are marked B E in *Plate* 15. They do the Office of *Fore-plains* in *Joynery*, and the *Jack-plains* in *Carpentery*, and ſerve only to take off the Irregularities the *Hatchet*, or ſometimes the *Draw-knife* leaves, after the work is hewed or drawn pretty near a Round with either of them: And therefore as the *Fore-plain* is made with a Corner-edge, only to take off the Irregularities of a Board, ſo the *Gouge*, that it may alſo take off the Irregularities or Extuberancies that lie fartheſt from the *Axis* of the Work, and alſo frame pretty near the hollow Moldings required in the Work, precede the *Smoothing-Chiſſels*. And that the *Gouge* may the more commodiouſly and effectually do it, the Blade of this Tool is formed about half round to an edge, and the two extream ends of this half round a little ſloped off towards the middle of it, that a ſmall part about the middle may the eaſier cut off the prominencies that are not concentrick to the *Axis*, and ſo bring the Work into a Method of Formation.

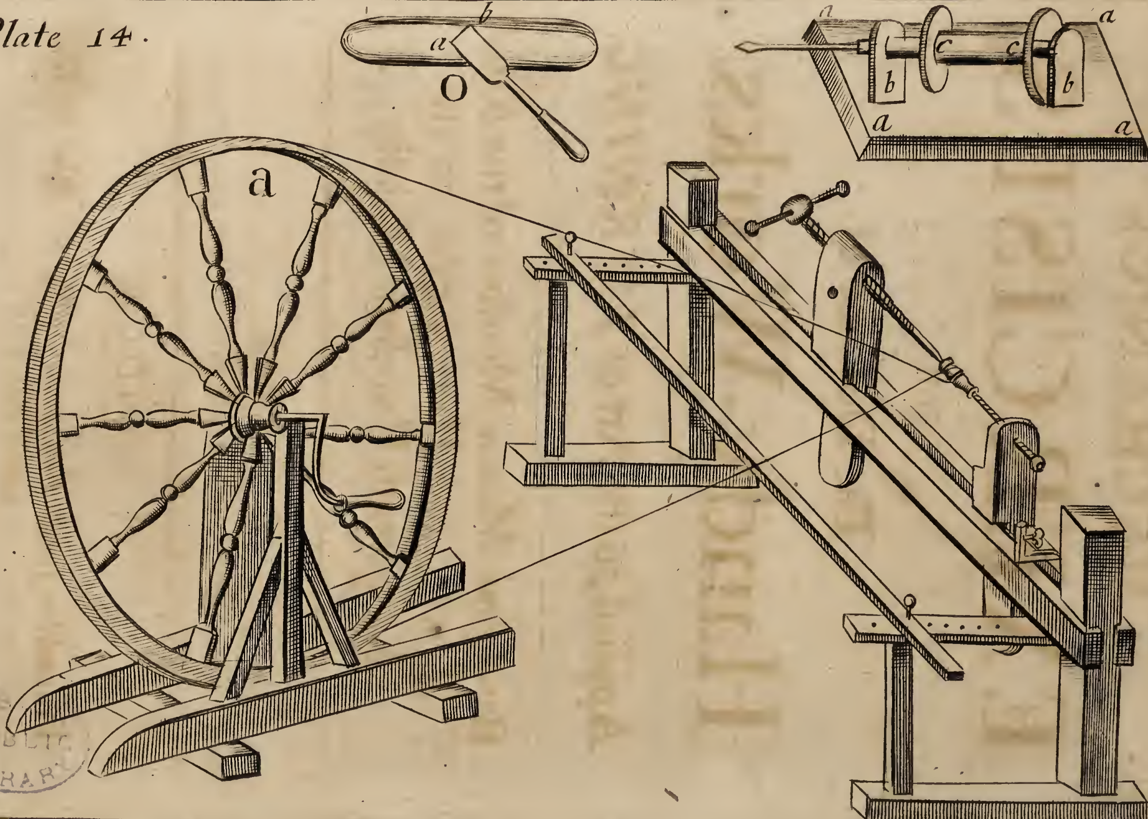
The hollow edge is ground upon the Corner of a *Grind-ſtone*, which in ſhort time wears the out-ſide of that Corner to comply and form with the hollow

of the *Gouge*. It is afterwards Set upon a round *Whetſtone*, that fits the hollow of the edge, or is ſomewhat leſs. But they do not Set their *Gouges* or *Chiſſels* as (I told you in *Numb*. 4. § 10.) the Joyners do; for *Turners* Tools being ſomewhat unweldy, by reaſon of their ſize, and long Handles, they lay the *Blade* of the *Gouge* with its convex ſide upon the *Reſt* of the *Lathe*; and ſo with the *Whetſtone* in their right hand they rub upon the *Baſil* the *Grind-ſtone* made, and as they rub, they often turn another part of the hollow of the edge to bear upon the round of the *Whetſtone*, till they have with the *Whetſtone* taken off the roughneſs of the *Grindſtone*.

Of theſe *Gouges* there are ſeveral ſizes, *viz*. from a quarter of an Inch to an whole Inch, and ſometimes for very large Work two Inches over.

The *Handles* to theſe *Gouges* (and indeed to all other *Turning Tools*) are not made as the *Handles* of *Joyners* or *Carpenters Tools* are, but tapering towards the end, and ſo long that the *Handle* may reach (when they uſe it) under the Arm-pit of the Workman, that he may have more ſtay and ſteddy management of the *Tool*.

Plate 14.



*Numb* XI.

# MECHANICK EXERCISES,

OR

The Doctrine of

# Handy-Works.

Applied to the Art of *TURNING.*

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By *Joseph Moxon*, Member of the *Royal Society*, and *Hydrographer* to the Kings most Excellent Majesty.

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LONDON,

Printed for *Joseph Moxon* at the Sign of *Atlas* on *Lud-gate-Hill*, 1680.

# *MECHANICK EXERCISES*;

## OR,

## The Doctrine of

# Handy-works,

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### § III. *Of Flat Chiſſels.*

THE *Flat Chiſſels* are marked CC in *Plate* 15. Theſe do the office of *Smoothing Plains* in *Joyning* and *Carpentery* : for coming after the *Gouges* they cut off the prominent Riſings that the *Gouges* leave above the hollow.

The edges of theſe *Flat Chiſſels* are not ground to ſuch a *Baſil* as the *Joyners Chiſſels* are, which are made on one of the Flat ſides of the *Chiſſels*; But are *Baſil'd* away on both the flat ſides; ſo that the edge lies between both the ſides in the middle of the *Tool* : And therefore either ſide of the *Tool* may indifferently be applied to the Work ; which could not well be, ſhould the edge lie on one of the ſides of the *Tool*: Becauſe, if they ſhould apply the *Baſil* ſide of the *Tool* to the Work, the thickneſs of the *Baſil* would bear the edge of the *Tool* off: And ſhould they apply that ſide of the

the *Tool* the edge lies on to the Work, the ſwift coming about of the Work would (where a ſmall irregularity of Stuff ſhould happen) draw or job the ſuddain edge into the Stuff, and ſo dawk it; which if the Stuff be already ſmall enough, would now be too ſmall; becauſe in *Turning*, all Irregularities muſt be wrought ſmooth down.

Of thoſe *Flat Chiſſels* there are ſeveral ſizes, *viz.* from a quarter of an Inch, one Inch, two Inches, to three Inches broad, according to the largeneſs of the Work.

Theſe are Set with the *Whetſtone* as the *Gouges* are, only they often turn the *Gouges* upon the round ſide, becauſe they would ſmoothen all the hollow edge; but theſe are laid flat upon the *Reſt*, and with a flat *Whetſtone* rubbed on the *Baſils*, as the *Gouge* was with the Round.

## § IV. *Of* Hooks.

THe *Hook* is marked D in *Plate* 15. As the *Gouge* is uſed when the Work lies before the Workman, *viz.* parallel to its *Axis*, and cuts right forwards, ſo the *Hook* is uſed when the Work ſtands on the right or left ſide the Workman, as the flat ſides of Boards to be *Turned* do; and therefore this work may be ſaid to lie athwart its *Axis*: and the *Hook* is made ſo as to cut on the right or left ſide a Board, and to tak off the extuberancies from the plain of the Board. But though this *Tool* does the Office of a *Gouge*, yet it is more difficult for a Workman to uſe than a *Gouge*; becauſe it is made thinner and ſlenderer than a *Gouge*, that its Edge cutting at a greater Bearing from the *Reſt*, may the eaſier come at the Stuff

Stuff it works upon, and the farther the Edge that cuts lies from the *Reſt*, the more difficult it is for a Workman to guide it; becauſe it is then more ſubject to tremble; eſpecially ſince (as aforeſaid) the Edge of the *Hook* is and muſt be thinner than the Edge of the *Gouge*.

Theſe *Tools*, as alſo the *Gouges* and *Flat Chiſſels*, are all about ten or twelve Inches long without the Handles.

The *Hooks* when they want ſharpening cannot be *ground* as the *Gouges* and *Chiſſels* are; but they muſt be firſt ſoftned in the Fire and turned ſtraight, and then brought to an Edge, and by heating again red hot turned into its form: Then muſt it be hardned and tempered as you were taught *Numb.* 3. *fol.* 57, 58. Yet do not Workmen proceed thus with their *Hook* every time it grows bluntiſh, but only when the Edge is either by long uſe or bad Temper grown ſo thick, that this following way will not help them: For they *Whet* the outer Edge with a *Whetſtone* as they do other *Tools*. But becauſe they cannot come at the inner Edge of the *Hook* with a *Whetſtone*, unleſs the *Hook* be very wide, and the *Whetſtone* very thin, they make uſe of a piece of Temper'd Steel, as ſometimes the thin ſide of a *Chiſſel*, or the back of a Knife, and ſo with the Edge of the Square, ſcrape along the hollow Edge of the *Hook*, and force the Edge as much to the outſide of the *Hook* as they can. Thus *Butchers* wear at their Girdles ſmall round Rods of Steel well Tempered and poliſht, that they may with quick diſpatch whet their Knives upon it, by forcing the Edge forwards upon the Blade, or preſſing down the Shoulder that hinders the Edges Entrance: For their Steels being ſo well poliſht, cannot properly be

 ſaid

ſaid to wear away any part of the Shoulder that ſhould hinder the Edge from doing its Office.

## § V. *Of* Grooving Hooks, *and* Grooving Tools.

THe *Grooving Hook* is marked E in *Plate* 15, and hath its *Tooth* of different forms, according to the Faſhion of the *Groove* to be made on the *Plain* of the Board; For ſometimes its *Tooth* hath a Flat Edge, ſometimes a round Edge, ſometimes a point only, and ſometimes two points, or other Forms as aforeſaid.

Its whole Blade is made much ſtronger than the *Gouge* and *Chiſſels*,and hath the ſides of its Edge more obtuſe to make it the ſtronger.

The *Flat Tools* work the Boards Flat either to the Plain of the Board, or to a Flat Groove in the Board.

The *Round Edge* cuts an half round hollow in the Board.

The *Point* cuts a fine Hollow Circle or Swage in the Flat of the Board; and being made Triangular, hath three Edges, each of which cuts the Ridges ſmooth down that the *Hook* left upon the Board.

The *two Point Grooving Hook* cuts two fine Hollow Circles or Swages on the Plain of the Board.

The *Grooving Hooks* do not work as the *Hooks* do; For the Hooks cut the Wood; but theſe do but indeed ſcrape off the Extuberancies, or fret into the Wood, and therefore they are very ſeldom uſed to Soft Wood, becauſe its being looſe, will not endure ſcraping without leaving a roughneſs upon the Work; But Hard Wood or Ivory (for the Reaſon converted) will.

§ VI.

## § VI. *Of* Mandrels. *And* ¶ 1. *Of* Flat Mandrels.

M*Andrels* are marked F 1. F 2. F 3. F 4. in P*late* 15. There are different Sorts of *Mandrels*, and the ſizes of them alſo different, accōrding to the ſizes of the Work.

1. *Broad Flat Mandrels* marked F 1. in P*late* 15. with three or more little Iron *Pegs* or *Points* near the Verge of its Flat: And theſe are uſed for the *Turning* Flat Boards upon. For the backſide of a Board placed Flat upon it, will, when ſcrewed up tight between the P*ikes*, by help of the Iron *Pegs*, remain in its place and poſition, whilſt the Flat ſide of the Work is working upon.

Behind the Backſide of this *Mandrel* (and indeed all other *Mandrels*) is fitted a long *Shank* or *Rowler*, for the *String* to be wound about while the Work is *Turning*. This *Rowler* muſt be ſo large in Diameter, that the *String* wound about it may command the Work about. If the Work be large and heavy, the *Rowler* muſt be bigger than if the Work be light; for elſe the *String* will not command it about: But if the Diameter of the *Rowler* be ſmaller, the Work comes ſo much ſwifter about. The *Rowler* muſt alſo be ſo long between its *Shoulders*, that it may conveniently contain ſo many Diameters of the S*tring* as ſhall be neceſſary to wind about it.

This whole *Mandrel* is marked F 1. in *Plate* 15. *a* The *Round Flat* or *Face* of the *Mandrel*. *b* The *Rowler*. *c c* The *Shoulders* of the *Rowler*. *d d d* The *Pegs*.

## ¶ 2. *Of* Pin-Mandrels.

2. M*Andrels* are made with a long Wooden *Shank*, to fit ſtiff into a round hole that is made in the Work that is to be *Turned*. This *Mandrel* is called a *Shank* or *Pin-Mandrel*, and is marked F 2. in *Plate* 15. And if the hole the *Shank* is to fit into be very ſmall, and the Work to be faſtned on it pretty heavy; then *Turners* faſten a round Iron *Shank* or *Pin* of the ſize of the Hole it is to be fitted into, and faſten their Work upon it. Theſe *Mandrels* with Iron *Shanks* are uſed by *Turners* that *Turn* Bobbins or ſuch like Work: Becauſe a Wooden *Shank* to fit the ſmall Hole through the Work would not be ſtrong enough to carry the Work about.

## ¶ 3. *Of* Hollow-Mandrels.

3. THere is another ſort of *Mandrels* called *Hollow Mandrels*, deſcribed F 3. *Plate* 15. It is both a *Hollow-Mandrel*, and alſo uſed to *Turn* Hollow Work in it. This *Mandrel* hath but one Center-hole belonging to it, *viz.* at the *Rowler* End or Neck; but it hath a *Shank*, which ſupplies the Office of another Center-hole. *a.* the *Hollow*, *b* the *Shank* or *Neck*. The *Hollow* is made ſo wide, that the Work intended to be *Turned* Hollow in it may fit very ſtiff into it, and ſo deep that it may contain the intended Work.

When it is uſed, it is pitcht upon the Center at the farther end of the *Rowler*, and hath its *Shank* put into one of the Holes of the *Joint-Coller* deſcribed in *Plate* 13. *fig.* G. that will beſt fit it: which Hole ſtand-

ing

ing directly againſt the P*ike* in the hinder P*uppet*, and receiving the *Shank* into it, guides the *Mandrel* about, as if it were pitch upon two Centers: And the Work being forced ſtiff into the Hollow of this *Mandrel*, will be carried about with it, expoſing the Fore-ſide of the Work bare and free from the *Joynt-Coller*, and not impeded by S*pikes* from coming at the Work: So that with the *Hook*, *Grooving-Hook*, *Gouge*, or *Flat-Chiſſel*, according as your Work requires, you may come at it to *Turn* your intended Form.

*Hollow Mandrels* are alſo uſed in *Collers* that open not with a *Joynt*; But then the *Spindle* is made of Iron, and hath a *Screw* juſt at its end, upon which is ſcrewed a Block with an Hollow in it, made fit to receive the Work ſtiff into it.

### ¶ 4. *Of the* Screw-Mandrel.

4. ANother ſort of *Mandrel* is called the *Screw-Mandrel*, and is marked F 4. in P*late* 15. *a* the *Rowler* of the *Mandrel*, *b* the *Shank* or *Screw* is made of Iron, having its two ends Round, and in the middle between the Round ends a Square the length of the *Rowler*, and this Square is fitted ſtiff into a Square Hole made through the middle of the *Rowler* that it turn not about in the Square Hole. In each Flat end of this Iron *Shank* or *Spindle* is made a Center-Hole, whereinto the P*ikes* of the P*uppets* are pitcht when this *Mandrel* is uſed. This Iron *Shank* or *Axis* muſt be made very ſtraight, and ought to be turned upon the two Center-Holes, for exactneſs; Becauſe on one of the Round ends, or ſometimes on both, a *Screw*, or indeed ſeveral *Screws* of ſeveral Diameters is made. That *Screw* next the end of the *Shank*

*Shank* is the ſmalleſt, *viz.* about three quarters of an Inch over, and takes up in length towards the middle of the *Shank*, about an Inch, or an Inch and an half; and ſo far from the end of the *Shank* it is of an equal Diameter all the way: And on this portion of the *Shank* is made a *Male-ſcrew* of the fineſt Thread. The next Inch and half (wrought as before) hath another *Male-ſcrew*; but about half a quarter of an Inch more in Diameter than the former, and hath its Threads courſer. Another Inch and half hath its Diameter ſtill greater, and its Threads yet courſer. And thus you may make the *Shank* as long as you will, that you may have the more Variety of Sizes for *Screws*.

Theſe ſorts of *Mandrels* are made for the making of *Screws* to *Boxes*, and their *Lids*, as ſhall be ſhewed in the next Paragraph.

## ¶ 5. *Of* Sockets *or* Chocks *belonging to the* Screw-Mandrel.

TO this *Screw-Mandrel* belongs ſo many *Sockets* as there are ſeveral ſizes of *Screws* on the *Shank*. They are marked F 5 in *Plate* 15. *a* the *Socket* or *Chock*: *b b* the Wooden Pin. *c* the *Stay*. *d d* the *Notch* to ſlip over the *Male-ſcrew*.

Theſe *Hollow Sockets* have *Female Screws* in them made before the Notch to ſlip over the *Male-ſcrew* of the *Screw-Mandrel* is cut. The manner of making *Female-ſcrews* is taught *Numb.* 2. *fol.* 29, 30, 31. only inſtead of a *Tap* (uſed there) you uſe the ſeveral and different ſizes of *Screws*, made on the *Screw-Mandrel* to do the Office of a *Tap* into each reſpective *Socket*; which *Sockets* being only made of Hard Wood, it will eaſily perform, though the *Shank* or *Axis* be but Iron.

There-

Therefore (as aforeſaid) to each of the *Male-ſcrews* on the *Screw-Mandrel* is fitted ſuch a *Socket*, that you may chuſe a *Thread* Courſer or Finer as you pleaſe: But this *Female-ſcrew* is open, or hath a *Notch* on one ſide of it, that it may ſlip over the *Male-ſcrew*, and the Threads of each other fit into each others *Grooves*; and when they are thus fitted to one another, the further or open ſide of the *Male-ſcrew* is gaged in, or pin'd on the *Female-ſcrew* with a Wooden *Pin* thruſt through two oppoſite Holes, made for that purpoſe in the *Cheeks* of the Wooden *Sockets*, that it ſhake not.

When the *Treddle* comes down in working, and the *Socket* is fitted on its proper *Screw*, and pinn'd ſtiff upon it, and the *Stay* held down to the *Reſt* of the *Lathe*, then will the *Socket*, and conſequently the *Stay* ſlide forwards upon the *Male-ſcrews*; ſo that a *Tool* held ſteddy on any part of the *Stay*, and applied to the out or inſide of your Work; that *Tools* point will deſcribe and cut a *Screw*, whoſe Thread ſhall be of the ſame fineneſs that the *Screw* and the *Shank* is of.

## § VII. *Of* Collers.

THere are ſeveral faſhion'd *Collers*: As the *Joynt-Coller* marked G, the *Round Coller* marked H, and the *Coller* marked I, in *Plate* 13.

The *Joynt-Coller* is made of two Iron *Cheeks* marked *b b*, which moving upon a Joynt *c* at the Bottom, may be ſet cloſe together; or elſe opened as the two inſides of the *Joynt-Rule Carpenters* uſe do. On the the Inner Edge of each *Cheek* is formed as many half-round Holes or Semi-cirles as you pleaſe, or the length of the *Cheeks* will conveniently admit: Theſe Semi-

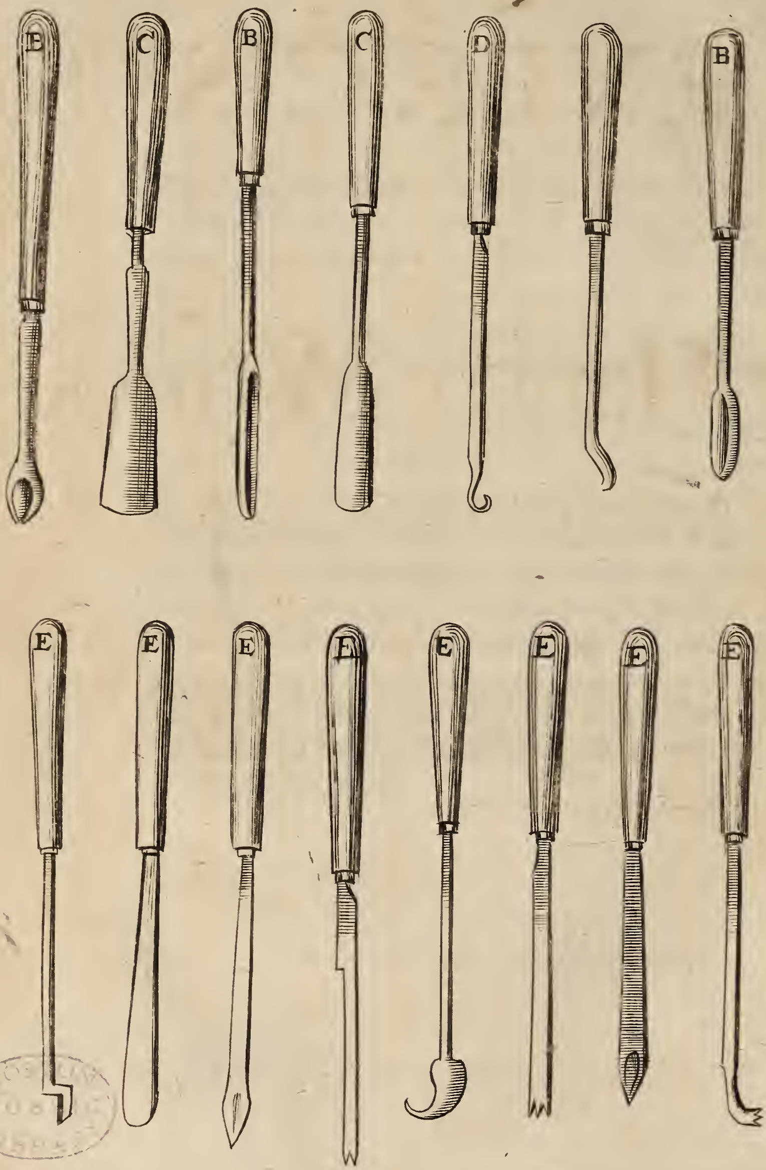
circles

circles are made of different Diameters,that they may fit the *Shanks* or *Necks* of different ſiz'd *Mandrels* : And theſe Semi-Circles muſt be made ſo exactly againſt each other on the edges of the *Cheeks*, that when the two *Cheeks* moving upon their *Joynt* are clapt cloſe together, the Semi-Circles on both the *Cheeks* ſhall become a perfect round hole or Circumference.

Near the top of one of theſe *Cheeks* is faſtned with a *Center-pin*,a Square Iron *Coller* marked *d*, with a ſmall *Handle* to it marked *e*. This ſquare *Coller* is made to contain the breadth of both the *Cheeks* when they are ſhut together, and to hold them ſo faſt together, that they ſhall not ſtart aſſunder; and yet is made ſo fit, that it may ſlip off and on both the *Cheeks*.

This *Joynt-Coller* may ſerve to do the office of the other two *Collers*, and its own particular Office too: yet to ſave the Charge of the price of this *Tool*, *Turners* ſeldom uſe them, but make ſhift with either of the other; or ſometimes with a Hole made in a Board only: But its particular Office is to hold a *Mandrel*, whoſe *Neck* is fitted to one of its *Holes*,and the Work they are to *Turn* is required to ſtand out free from the outer Flat of the *Cheeks* of the *Coller*, the better to come at it with the *Tool*: ſuch as are deep *Boxes*, or deep *Cups*, &c.

Plate 15.



*Numb.* XII.

# MECHANICK EXERCISES, OR The Doctrine of Handy-Works.

Applied to the Art of *TURNING.*

By *Joseph Moxon*, Member of the *Royal Society*, and *Hydrographer* to the Kings most Excellent Majesty.

LONDON,

Printed for *Joseph Moxon* at the Sign of *Atlas* on *Ludgate-Hill*, 1680.

# *MECHANICK EXERICSES,*

## OR,

## The Doctrine of

# Handy-works,

## Applied to the Art of *TURNING.*

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### § VIII. *Of the* Mawl.

THE *Mawl* is marked K in *Plate* 13. The Figure of it there is Deſcription ſufficient: Its Office is to knock and unknock the *Wedge* in the *Puppets*: and to knock upon the back of the *Cleaving Knife*, when they ſplit their Wood for their Work. The *Joyners Mallet* would ſupply the Office of this *Tool*; but Uſe has made the *Mawl* more handy for them: Beſides when one is batter'd to ſhivers, they can quickly of a Chump o Wood accommodate themſelves with another.

### § IX. *Of the* Hatchet, Draw-knife, *and* Cleaving-Knife.

THE *Hatchet* is marked L in *Plate* 4. It is of the ſame ſort that *Joyners* uſe; which I deſcribed *Num.* 5. § 25. and therefore refer you thither.

And the *Draw-knife* is deſcribed in *Numb.* 7. § 5. *Plate* 8. marked E. The *Cleaving-knife* marked M in *Plate* 13. needs no other Deſcription than that Figure.

## § X. *Of the* Chopping-Block.

THE *Chopping-Block* is marked N in *Plate* 13. It is made of a piece of *Elm-Tree* placed with its Grain upwards and downwards as it grew. It hath three Legs in it, that ſtand ſtradling out from the underſide of the *Block* to the Floor, and of ſuch an heighth, as the Workman may have moſt Command of the Work. See the Figure. Sometimes *Turners* uſe inſtead of it a piece of the Trunk of a Tree of about a Foot and an half or two Foot in length from the Ground, or more or leſs.

## § XI. *Of the* Callippers.

THE *Callipers* is marked O in *Plate* 13. As common Compaſſes (deſcribed *Numb.* 6. § 32.) are for meaſuring Diſtances upon a plain Superficies; ſo *Callippers* meaſure the diſtance of any round *Cilindrick* Conical Body, either in their Extremity, or any part leſs than the Extream: So that when Workmen uſe them, they open the two points *a a* to their deſcribed width, and *Turn* ſo much Stuff off the intended place, till the two points of the *Callippers* fit juſt over their Work; ſo ſhall their Work have juſt the Diameter in that place, as is the diſtance between the two points of the *Callippers*, be it either Feet or Inches, *&c.*

## § XII. *Of the* Drill-Bench.

THere is yet another *Tool*, or rather a *Machine* uſed by ſome *Turners*, called a *Drill-Bench*. It is deſcribed in *Plate* 14. *a a a a* a thick Board, about three Inches thick, five Inches broad, and eighteen Inches long. *b b* two *Stiles* placed towards either end, and faſtned upright. In the hithermoſt *Stile* is a *Coller* deſcribed § 7. and *Plate* 13. H, or any of the other *Collers*: And in the further *Stile* is fitted a ſquare flat tempered piece of Steel having a Center-hole in the middle of it, and is placed juſt againſt the Center or middle point of the Hole of the *Coller*. *c c* the *Rowler* whoſe hither end is *Turned* away, ſo as it juſt fit into the *Coller*, and at the further end of it, it hath a temper'd *Steel Pin*, to be placed in the Center-hole: And in the middle of the hither end of it, it hath a *Piercer-Bit* faſtened ſtraight in, ſo that it lie in a true ſtraight Line, with the *Axis* of the *Rowler*. Of theſe *Rowlers* they have ſeveral, and *Bits* of different ſizes fitted into them, that upon all occaſions they may chuſe one to fit their purpoſe.

On the under-ſide, about the middle of the *Bench*, is fitted and faſtned athwart it a ſquare Iron *Coller*, deep enough to reach through the *Cheeks* of the *Lathe*, and ſo much deeper as it may receive a Wooden *Wedge*, ſuch a one as belongs to one of the *Puppets*: And by the force and ſtrength of the *Wedge* the whole *Drill-bench* is drawn down, and faſtned athwart the *Cheeks* of the *Lathe*.

When it is uſed, it ſtands athwart the *Cheeks* of the *Lathe* (as aforeſaid) with the point or end of the *Bit* towards you; and then the *String* being turned twice

or thrice about the *Rowler*, will (with *Treading* on the *Treddle*) turn the *Rowler* and its *Bit* forcibly about, and cauſe it enter ſwiftly into a piece of Wood that ſhall be preſt forwards upon the *Bit*.

When they uſe it, they hold the piece of Wood they intend to *Drill* or *Pierce* faſt in both their Hands, right before them, and preſs it forwards upon the *Piercer Bit*; ſo that by its running about, it cuts a ſtreight round hole into the Wood of what length they pleaſe.

But while the *Pole* is riſing after every *Tread*, they preſs not againſt the *Piercer-Bit*, ſo that it is diſ-ingaged from doing its Office in the Wood; but in that while, they nimbly give the Wood a turn in their hands, of about one third part of its Circumference; which makes the *Bit* every ſucceſſive *Tread*, go the ſtraighter through the middle of the Wood: And thus they reiterate *Treads* and keep the Wood turning in their Hands, till the *Bit* is enter'd deep enough.

Thus much for the *Tools* uſed in common *Turning*: I ſhall proceed to the working a Pattern or two in in Soft Wood; which being well underſtood, may render a Practicer capable of moſt Common Work.

## § XIII. *Of* Turning *a* Cilinder *in Soft Wood*.

THE Soft Wood *Turners* Uſe is commonly either Maple, *Alder*, *Birch*, *Beech*, *Elm*, *Oak*, *Fir*, &c. and for ſome particular purpoſes each of theſe ſorts are beſt.

The Firſt Patern we purpoſe, ſhall be a *Cilinder* two Inches over, and eight Inches long: Therefore you muſt chuſe a piece of Wood at leaſt two Inches and a quarter over, leſt you want Stuff to work upon: Nay, if your Stuff prove ſhaken or otherwiſe unſound,

unſound, or your Centers be not very exactly pitcht, you may want yet more Stuff; and that according as it proves more or leſs faulty, or as the Centers are more unequally pitcht. But ſuppoſing the Stuff good, you may take a piece of two Inches and a quarter over, as I ſaid before, and about ten or eleven Inches long: For though the length of the *Cilinder* be but eight Inches, yet you muſt cut your Stuff long enough to make a Groove at one end of it beſides, for the *String* to run in. If your Stuff be ſomewhat too big for your Scantlin, and not round enough to go into the *Lathe*, you muſt *Hew* it pretty near with the *Hatchet* to make it ſizable, and afterwards ſmoothen it nearer with a *Draw-knife*, as you were taught *Numb.* 7. § 5.

But if you have not Stuff at hand near your ſize, then you muſt Saw off your length from a Billet, or ſome other piece of Stuff, and with the *Cleaving-knife* and the *Mawl*, ſplit it into a ſquare piece near the ſize, and with the *Draw-knife* round off the Edges, to make it fit for the *Lathe*.

Then ſet your *Puppets*, and wedge them tight up, ſo as the *Points* of your *Spikes* ſtand pretty near the length of your Work aſſunder, and move the *Pole*, ſo as the end of it may hang over between the *Pikes*, and alſo fit the Iron *Pin* in the *Treddle* into a proper *Hole* in the *Croſs-Treddle*, ſo as the end of the *Treddle* may draw the *String* below the Work into pretty near a ſtraight Line with the *String* above the Work: And take the Work in your Right hand, and put it beyond the *String* before you, and with your left hand wind the *String* below the Work but once about the Work, leſt it ſhould be too ſtrong for your ſhallow Centers, as you ſhall underſtand by and by,

 and

and then with a pretty ſtrength preſs the middle of one end of your Work over the Point of one of the *Pikes*, and ſo make a hole in your Work for one of the Center-holes: Then ſcrew your *Pike* wider or cloſer according as the length of your Work requires, and pitch the other end of your Work upon the other *Pike* alſo, and ſcrew your Work a little lightly up: Then try how the Centers are pitcht, by Treading the *Treddle* lightly down; and if you find the Centers are well pitcht, you may without more ado ſcrew up your Work tight: But if your Centers, or either of them be not well pitcht, you muſt alter them. You may know when they are well pitcht, by treading ſoftly upon your *Treddle*, and holding your Finger ſteddy on the *Reſt*, direct the point of it pretty cloſe to the Work: For if in a Revolution of your Work, its Outſide keeps at an equal diſtance from the end of your Finger, you may conclude your Work is well pitcht. But if you find one ſide of your Work comes nearer your Finger than the other ſide, you muſt with your *Flat Chiſſel* or *Gouge*, (or what is neareſt at hand) knock ſoftly, or hard, upon that ſide that comes neareſt to your Finger, till you have forc'd the *Pikes* into the true Centers at the end of your Work; and then you may boldly ſcrew it hard up: But you muſt be ſure to ſcrew it hard up; becauſe it is Soft Wood you purpoſe to work upon, and the ſtrength of the *Pole* may endanger the drawing or removing the Centers, if the *Pikes* have not good hold of them.

Having found your Centers, take your Work again off the *Pikes*, and wind the *String* once or twice more about your Work, that your *String* (as I ſaid in *Numb.* 10. § 1. when I wrote of the *String*) may theb ettercommand it,and then wind off or on more

*String*

*String* at the end of your *Pole*, or end of your *Treddle*, or both, if your Work require it, till the *Pole* draws the *Treddle* up a little above half the length of the *Legs* of the *Lathe:* For about that heighth your Leg may without ſuddain tyring command the *Pole* down again.

But before you begin to work upon the Stuff, I ſhall inform you how to *Tread* the *Treddle*; In which you may obſerve this General Rule; That the nearer the Fore-end of the *Treddle* you *Tread*, the eaſier you bring down the *Pole*; But then the *Pole* in its Spring raiſes your Leg the higher, and may draw the upper ſide of your Thigh againſt the underſide of the *Cheek* of the *Lathe*, and with reiterarated Riſings Gawl and alſo tyre your Thigh.

Place therefore your Foot ſteddy upon the *Treddle*, ſo far forward as you can to avoid the *Poles* Riſing from drawing your Thigh againſt the underſide of the *Lathe*; and Tread the *Treddle* nimbly down, but not quite ſo low as to knock againſt the Floor: Then abate the weight of your Tread, and let the *Pole* draw the *Treddle* up; but ſtill keep your Foot ſteddy, and lightly Bearing upon the *Treddle* : For then your ſucceeding *Treads* will prove eaſier to your Leg and Thigh, and you will with your Foot the better and quicker command the *Treddle*. Then *Tread* again nimbly down as before, and keep this Train of Treading till your Work be finiſh'd, or that you may have occaſion to ſtop and examine how rightly you proceed.

In all ſmall Work the *Tread* is lightly and nimbly performed; but in large and heavy Work the *Tread* comes ſlow and heavily down.

This

This being premiſed, you may begin with your *Gouge*: Lay the Round ſide of it upon the *Reſt*, and take the Handle of it in your Right hand, and lay the Fore and Middle Fingers of your Left Hand upon the Hollow of the *Gouge* near the Work, mounting the Edge about a quarter of an Inch above the *Axis* of your Work, and ſinking your Right hand a little: for in this poſition the *Gouge* cuts beſt: And thus cut down on your Work near one end a *Groove* for your *String* to run in: The *Groove* may be about an Inch, or an Inch and an half long: But it matters not much what depth. Then ſlip your *String* into the *Groove*, and if you find the *String* will not ſlip eaſily, you may put your Foot under the *Treddle*, and lift it a little up, that the *String* when no weight is hanged to it, may ſlide the eaſier into the *Groove*.

And by the way you may take notice, that the deeper you cut down the *Groove*, the oftner will your Work come about every Tread; becauſe the *String* that comes down every Tread, meaſures a ſmall Circumference oftner than it does a greater Circumference: But then the Work is not ſo ſtrongly carried about; becauſe it hath a leſs portion of the *String* to command it. This I hint, not that in this our ſmall propoſed Pattern it is very conſiderable: For if you only cut the *Groove* down but ſo low as there may be a Shoulder at the end, and another againſt the Work, to keep the *String* from ſlipping out of the Groove, it will be ſufficient: But in Heavy Work this *Groove* ought to be cut with diſcretion.

Now come to the Forming of your Work, and hold your *Gouge* as you were taught before, but ſomewhat lightly againſt your Work, beginning at one end, and ſliding your *Gouge* gradually to the other, cutting with

with its Edge all the way you go, and bearing ſome-what ſtiff againſt the Work every Tread you make on the *Treddle:* And withdrawing it again a little lightly from the *Work* every Spring of the *Pole.* And thus by Uſe you muſt habituate your ſelf to let the Edge of your *Tool* bear upon the Work when the *Pole* and *Treddle* comes down, and to draw it back juſt off the Work, as the *Pole* and *Treddle* goes up. And thus you muſt continue till you have rough-wrought all your Work from end to end.

If you have not at firſt brought your Work clean; that is, if you have not gone deep enough with your *Gouge* to take off all the Riſings of the Stuff the *Draw-knife* left, even with the ſmalleſt part of your Work, you muſt in like manner (as before) work it over again. But you muſt have a ſpecial Care you take not too much Stuff away on any part of the Whole Work: For this propoſed Pattern being a *Cilinder*; if you take but a ſmall matter too much a-way from any part, and make it ſmaller than your given meaſure there, the whole Work will be ſpoil-ed; as being ſmaller than the propoſed Diameter: Which to know, you may by opening the Points of your *Callippers* to two Inches on your *Rule* (the pro-poſed Diameter of your *Cilinder*) try if the Points at that diſtance will juſt ſlip over the deepeſt *Grooves* of your Work (for we will not ſuppoſe that the *Grooves* are of an equal depth with the Rough-work-ing of the *Gouge*) without ſtraining the Joynt: For then your Work is juſt ſizable: If not work over again as before, &c. But we will now ſuppoſe you have not taken too much away, but have made a due pro-ceſs with your *Gouge.* Therefore now proceed and uſe a *Flat Chiſſel*, about an Inch and an half broad,

to take off the Irregularities the *Gouge* left.

Take the Handle of it in your Right Hand as you did the *Gouge*, and clafping the *Blade* of it in your Left Hand, lean it fteddy upon the *Reft*, holding the Edgle a little aflant over the Work, fo as a Corner of the thin fide of the *Chiffel* may bear upon the *Reft*, and that the Flat fide of the *Chiffel* may make a fmall Angle with the *Reft*, and confequently with the Work; (which is parallel to the *Reft*) for fhould you fet the edge of the *Chiffel* parallel to the Work, it might run too faft into the Work, and dawk it. Therefore you muft fet the *Chiffel* in fuch a pofition that the lower Corner, or near the lower Corner of the edge may cut lightly upon the Work: But this pofition is beft defcribed by a Figure, which to that purpofe I have inferted in *Plate* 14. at O, where you may perceive in or near what pofition the *Chiffel* muft be fet to cut the Work; and how the edge of the *Chiffel a b* lying aflant the Work, and the further Corner of the edge of the *Chiffel b* being fomewhat mounted, as the Work comes about, the Bottom or near the Bottom of the edge of the *Chiffel* is only capable to cut a narrow Shaving off of the Work: and juft in this manner you muft keep the *Chiffel* fteddy bearing upon the Work, as the *Pole* comes down, and withdrawing it from the Work as the *Pole* Springs up(as you were taught to ufe the *Gouge*)and at the fame time fliding it forwards from one end of the Work to the other, till it be wrought down all the way to its true Diameter between the points of the *Callippers*: For then a ftraight *Ruler* applied to your Work, the outfide of your propofed *Cilinder* will be formed.

Only the ends muſt be cut down ſquare to the length: Therefore open the points of your Compaſſes to the diſtance of eight Inches on your *Rule*, and prick that diſtance hard off upon your Work, that the points of your *Compaſſes* may leave viſible marks, by placing one point as near one end as you can, to leave Stuff enough to cut ſtraight down all the way; that is, to cut it ſquare down at right Angles with the outſide of the Work. Which to do, you muſt hold the Handle of the *Flat Chiſſel* in your Right hand (as before) and claſp the Blade of it in your Left, and lay one of the thin ſides of it upon the *Reſt*, ſo that the edge may ſtand upright, or very near upright againſt the Work. Then ſink your Right hand ſomewhat below the Level of the *Reſt*, that the lower Corner of the edge of the *Chiſſel* may mount, and being thruſt ſteddy againſt the Work juſt in the mark one Point of the *Compaſſes* made, Tread the *Treddle*, and cut a pretty deep Circle into the Stuff. But you muſt have a care you do not direct the cutting Corner of the *Chiſſel* inwards, but rather outwards, leſt you make the end hollow inſtead of Flat: For if you do take off too little at firſt, you may by degrees cut it down to a Flat afterwards. As you cut deeper into the Stuff, you muſt turn the Flat of the *Chiſſel*, and with it cut down the Shoulder juſt at the end on the out ſide the mark, for elſe that may hinder the Corner of the Edge of the *Chiſſel* for coming at the Work.

Note, that if you hold not the edge of the *Chiſſel* truly before the Work, but direct it inwards, and if you hold it not very ſteddy, and have a good guidance of it, the quick coming about of the Work may draw the edge of the *Chiſſel* into it inwards,

 and

and run a dawk on the *Cilinder*, like the Groove of a Screw; and so spoil your Work: For being once wrought to the true size, you cannot afterwards take any more off to cleanse it, &c.

The other end must be cut down as this.

## § 14. *Of* Turning Flat Boards.

IF your Board be thick enough, you may boar a round Hole in the middle of it; and Turn a *Mandrel* with a *Pin* a very little Tapering, to fit hard and stiff into the round Hole: And if the *Hole* and *Pin* be proportionable in size to the weight of the Board, the *Pin* will carry it about. But you must be very careful the *Hole* be boared exactly straight through the middle, and not inclining on either side the Board more to any part of the Verge than to another; but that the middle of the *Hole* be exactly the Center of the Board the whole thickness though. This *Pin-Mandrel* is described *Numb.* 11. § 6. and *Plate* 13.

If your Board be not thick enough to be fastned upon a *Pin-Mandrel*, or that your Work will not admit of an Hole to be bored through the middle of it, you may use the *Flat Mandrel* described *Plate* 13. F 2. And then you must with your *Compasses* find the Center on the backside of the Round Board (with several proffers if need require) till you have found it, and prick there an Hole for a mark: Then open the points of your *Compasses* to about the thickness of a Shilling wider than the Semidiameter of the *Flat Mandrel*; and with the points of your *Compasses* at that distance describe a Circle on the backside of the Board to be Turned, by placing one Foot in the

the prickt mark, and turning about the other Foot. By this Circle you may pitch the Center of the Board exactly upon the Center of the *Flat Mandrel:* For the points of the *Compasses* being opened about the thickneſs of a Shilling wider than the Semidiameter of the *Flat Mandrel* will (when you have pitcht the Center of the Board on the Center of the *Mandrel*) place the outer Verge of the *Mandrel* the thickneſs of a Shilling round about within the Circle deſcribed on the backſide of the Board: And when it is thus pitcht, you may by laying the Board flat down knock upon the *Rowler* end of the *Mandrel*, and drive the *Pegs* in the flat of the *Mandrel* into the Board,and ſo hold it ſteddy upon the *Mandrel*: Then find the Center on the Foreſide of the Board alſo, as you were taught to find the Center on the backſide, and put your Board and *Mandrel* upon the *Pikes* of the *Puppets*, and ſcrew them hard up, as you have been taught before.

Sometimes *Turners* uſe this *Flat Mandrel* without *Peks*, and then they chalk the Flat ſide of it very well, and clap the backſide of the Board to it, which will (if the Board to be *Turned* be not too heavy, but be well ſcrewed up between the *Pikes*) keep the Board ſteddy from ſlipping from its ſet-poſition, till you work it.

If in going about of your Work you find it *Wabble*, that is, that one ſide of the Flat incline either to the Right or Left Hand, you muſt with ſoft Blows of an Hammer or other Tool at hand ſet it to right, and then again ſcrew it hard up: For ſo often as you thus ſtrike upon the Verge to ſet the Board true, you force the Steel point of the *Pike* more or leſs (according to the ſoftneſs of the Wood)

 towards

towards that ſide of the Verge you ſtrike upon; and therefore you may perceive a reaſon for ſcrewing up the *Pike* ſo oft as you knock upon the outer Verge of the Board.

But we will now ſuppoſe the Board well pitcht and faſtned on the *Mandrel* and Center; Therefore take the *Side-Reſt* deſcribed in § 1. *Numb.* 10. ¶ 7. and P*late* 13. at the Figure e, and f g, and fit it ſo into the *Lathe* as the upper edge of it may ſtand range, or parallel to the ſide of the Board you are to work upon; and ſo wedge it hard up.

Now you muſt come to uſe the *Hook*, deſcribed *Numb* 12. § 5. and P*late* 15: For this Tool is moſt commodious to ſerve you inſtead of the *Gouge*, when the Work ſtands athwart the P*ikes*; becauſe the end of the Blade of this Tool being on its Flat ſide turned into a Circular Figure, and that Circular Figure turned a little backwards, one of the Edges of this Circular Figure will conveniently (though the Tool be not held ſtraight before the Work) come at any part of the Flat of the Board, and ſo by the Circulation of the Board againſt the Edge of the *Hook* cut off its irregular Extuberances.

In the uſing of this Tool, you muſt place the end of the *Handle* under your Arm-pit, and hold your left hand on the upper ſide of the Blade of the Tool cloſe to the *Reſt*, and your Right hand cloſe beſides your Left Hand under the Tool, and with both your hands claſp the Tool hard, and preſs it ſteddy upon the *Reſt*, and at the ſame time hold it alſo ſteddy, and yet lightly bearing againſt the Work, that by the ſwift coming about of the Work it draw not the Edge of the thin and tender Blade of the *Hook* into it.

You

You must not hold the Blade of this Tool perpendicularly before the Work, *viz.* parallel to the *Pikes*, but aslant, so as somewhat about the middle of the Convex of the *Hook* may touch against the Work. You may begin at the Verge, and so lay several Grooves close by one another till you come to the Center: But you must observe (as was said before in the *Cilinder*) that you lay all your *Grooves* of an equal depth into the Board: For if you lay one deeper than the rest, and an Hollow may not properly be in that place, you must again go over your work with your *Hook*, to work that dawk out: And then perhaps your Board may be made too thin for its intended purpose. But this Craft of the Hand must be acquired with some continued Use and Practice, which will better inform your Judgment what Errours you may be subject to commit, than many words (though significant) upon this Doctrine. And this I'me sure I found, when I first practised upon *Turning*.

Having thus with the *Hook* rough-plain'd the Board (for this *Hook* does in *Turning* the Office of a *Fore-plain* in *Joynery*) you must use the *Triangular Grooving Tool*, described *Numb.* 11. § 5. *Plate* 15. and with one of its Edges smoothen down the ridges the *Hook* left on the Board.

But if your Work require any Molding near the Verge or any other part of it, you must work that Molding as near as you can with the *Hook*, especially where Hollows are requir'd; for that cuts faster and smoother than any other Tool, and most artificially forms an Hollow.

If a Flat be to be laid in the Board, you must first use the *Triangular Point Tool*, and with it

strike

ſtrike ſo many Threds as the breadth of the Flat requires, and lay each Thred almoſt ſo deep into the Board as you intend the Flat ſhall be: And afterwards to ſmoothen it down, you muſt uſe the *Flat Grooving Tool*, or a *Flat Chiſſel*, and with either of them finiſh the Flat to its intended Depth and Breadth. And where a fine Thread or Circle is to be laid in the Board, you muſt uſe the *Triangular Point Tool.* And thus as you ſee occaſion, you muſt accommodate your ſelf with a Tool apt and proper for your purpoſe *viz.* ſuch a Tool as will moſt conveniently come at, and form the intended Work.

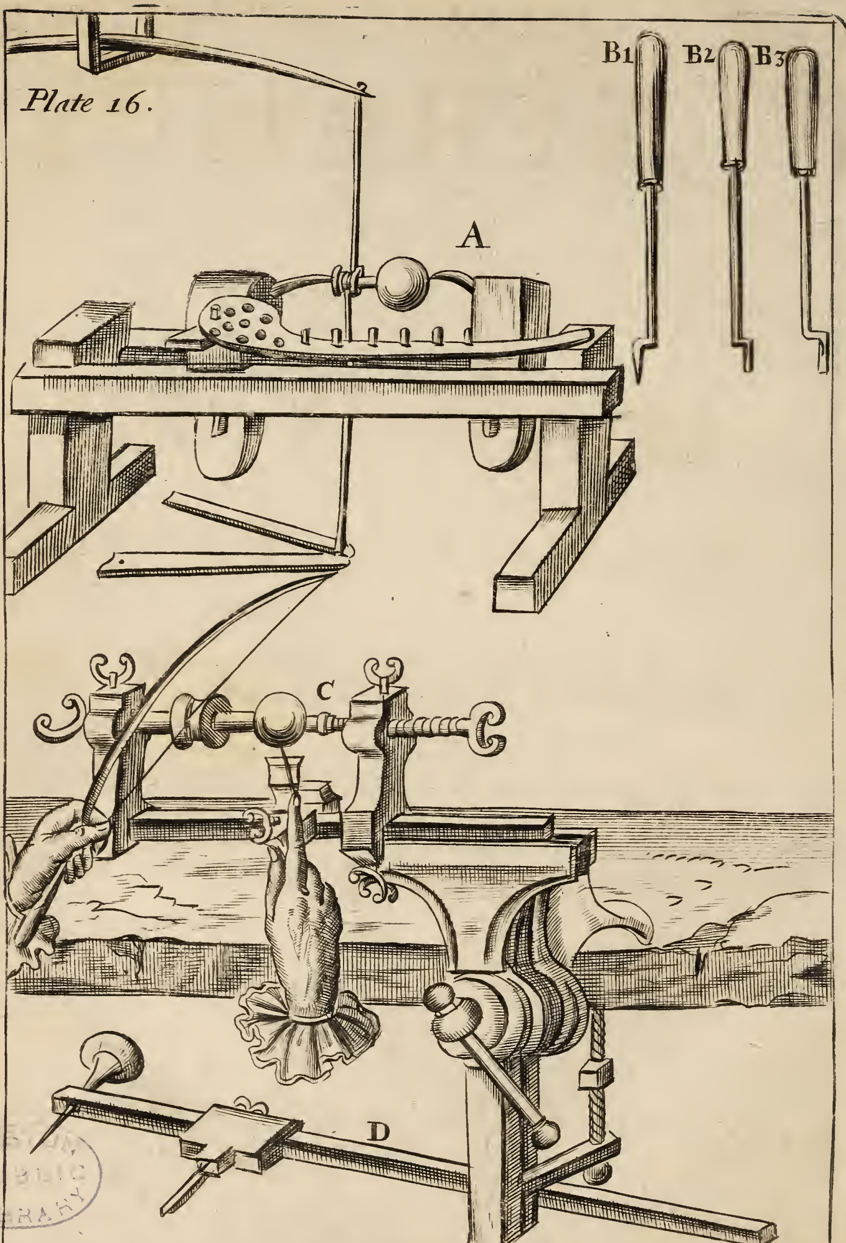


Plate 16.
A
B1
B2
B3
C
D

Numb. XIII.

# MECHANICK EXERCISES, OR The Doctrine of Handy-Works.

Applied to the Art of *TURNING*.

By *Joseph Moxon*, Member of the *Royal Society*, and *Hydrographer* to the Kings most Excellent Majesty.

LONDON,

Printed for *Joseph Moxon* at the Sign of *Atlas* on *Ludgate-Hill*, 1680.

# *MECHANICK EXERICSES,*

O R,

# The Doctrine of

# Handy-works,

# Applied to the Art of *TURNING.*

## § XV. *Of Turning* Hard Wood, *and* Ivory.

IF the Wood be very hard, as *Ebony, Lignum Vitæ*; or if it be *Ivory, Bone* or *Horn* they are to Turn; they neither uſe the ſame Tools they do for Soft Wood; becauſe their edge is too tender: nor dothey uſe their othe rTools as they do ſoft Wood, For the Tools made for Hard Wood are made with a ſtonger Point,edge,*&c.*than they arefor Soft,as was ſaid *Nnmb.* 11. § 5. And they uſe them differently; becauſe for Turning Soft Wood they hold the Edge of the *Gouge* and *Flat Chiſſel* at ſome conſiderable Diſtance from the *Reſt*, mounting the Edge at ſuch an Angle as will beſt cut off from the Work as great a Chip as they can, or deſire. And as they Turn the Work ſmaller,they guide the *Chiſſel* to follow the Work:But for Hard Wood they raiſe the *Reſt* near the Horizontal Plain of the *Axis* of the Work, ſetting it as cloſe as conveniently they can to their Work, and lay their Tool flat and ſteddy upon the *Reſt*; which being hard held in this po-

 ſition,

ſition, does by the coming about of the Work, cut or tear off all the Extuberances the Tool touches in the ſweep of the Work. So that (as I ſaid before) as in *Turning* Soft Wood the Tool does ſomewhat follow the Work ; in *Turning* Hard Wood the Work comes to the *Tool*: And therefore you may perceive a great reaſon they have to keep the *Tool* ſteddy : For ſhould it in one ſweep of the Work be thruſt nearer the *Axis* in any place, it would there take off more than it ſhould.

Having prepared the Work fit for the *Lathe*, either with Hewing (as hath been ſhown *Numb.* 5. § 7. and *Numb.* 11. § 13.) or, as ſome Hard Woods and Ivory may require, with Raſping, they pitch it between the *Pikes*, as before has been ſhown, or ſuch Work as it may be, as Boxes, and generally all Hollow Work, they fit into *Collers*, either by ſcrewing the *Mandrel* on an Iron *Axis* ; or fitting it with ſome other of the *Mandrels* deſcribed *Numb.* 11. § 6. as is proper for it: As ſometimes they fit the Work tight into an *Hollow Mandrel*, and the tight fitting in holds it whilſt it is working upon: And ſometimes, if the Work be very thin, they fix it on a *Flat Mandrel* with Cement ; But they are always either to chuſe one of the *Mandrels* deſcribed already in *Numb.* 11. § 6. or elſe contrive (as they often do) ſome other *Mandrel* convenient to the opportunity that accidentally their Buſineſs may require. For the Work (whether it be pitcht on the *Pikes*, or fitted into *Hollow Mandrels*, or otherwiſe) muſt run very ſteddy and tight about.

But having thus fitted it into the *Lathe*, they begin to work with the *Sharp-pointed Grooving Tool*, or elſe with the *Triangular Grooving Tool*, and with the point

of

of either of theſe *Tools* break the Grain of the Wood, by laying ſmall Grooves upon its Surface, till they have pretty well wrought away the Extuberances, and brought the Work tollerably near an intended ſhape, by ſtreightning, hollowing, and leaving Riſings in their ſeveral proper places.

Afterwards with Edg'd *Grooving Tools* of a proper Breadth, they cut down and ſmoothen away the Extuberances left by the *Sharp-pointed Grooving Tool*, or the *Triangular Grooving Tool*, and bring the Work into a perfect ſhape. Which done, they ſmoothen the work with the Edge of a piece of a Blade of a broken Knife, baſil'd away, by following the Work with it: That is, holding the baſil'd Edge of the Knife cloſe againſt the Work while it comes about: For then its ſharp Edge ſcrapes or ſhaves off the little roughneſs the groſſer *Tools* left upon the Work.

Laſtly, they hold either a piece of Seal Skin or Dutch Reeds (whoſe outer Skin or Filme ſomewhat finely cuts) pretty hard againſt the Work, and ſo make it ſmooth enough to poliſh.

Hard Wood they poliſh with *Bees Wax*, *viz.* by holding *Bees Wax* againſt it, till it have ſufficiently toucht it all over; and preſs it hard into it by holding hard the edge of a Flat piece of hard Wood made ſizable and ſuitable to the Work they work upon, as the Work is going about. Then they ſet a Gloſs on it with a very dry Woollen Rag, lightly ſmear'd with *Sallad Oyl.*

But *Ivory* they poliſh with Chalk and Water, and afterwards dry it with a Woollen Rag, and a light touch of *Sallad Oyl*; which at laſt they rub off again with a dry Woollen Rag, and ſo ſet a Gloſs on it.

If there be a Screw to be made upon the thin Edge of an *Ivory*, or *Hard Wood*, or *Braſs Box*, they uſe the *Screw Mandrel*, and its *Socket*, deſcribed *Numb.* 11. § 6. ¶ 4 and 5. as is ſhewn at the latter end of that Section.

## § XVI. *Of* Turning *long and ſlender Work of* Ivory.

SOme *Turners* to ſhew their Dexterity in *Turning*; and make others that know not the way how it is done admire at their Skill, *Turn* long and ſlender Sprigs of *Ivory* as ſmall as an Hay-ſtalk, and perhaps a Foot or more long: which to perform they cut a piece of *Ivory* to its intended length; but ſtrong enough to bear working till they bring it to as ſmall a *Cilinder* as they can; which being thus forwarded, they place a *Joynt Coller* (as is deſcribed *Numb.* 11. § 7.) made ſmall and fit for their purpoſe, juſt in the middle of their Work: only that their Work may *Bear* at a ſmaller length, and conſequently be ſtronger for being thus ſupported while it is *Turned* yet ſmaller. Then they place other *Collers* between the *Pikes* and the middle *Coller*, and *Turn* the whole Cilinder ſlenderer yet. And thus by placing *Collers* where ever they find the Work buckle, they (as aforeſaid) with *Sharp Tools*, tender touches, ſomewhat a looſe and fine *String*, weak Bow, and great care and diligence work the whole Cilinder down as ſmall as they liſt, either with Moldings or other Work upon it, as beſt likes them.

The propereſt *Lathe* to *Turn* this ſlender Work in is the *Turn-Bench* deſcribed § 18. *Plate* 16.

§ XVII.

## § XVII. *Of the* Brasiers Lathe *and* Turning Tools; *and their manner of using them.*

BRasiers that *Turn* Andirons, Pots, Kettles, *&c.* have their *Lathe* made different from the Common *Turners Lathe*, as you may see in *Plate* 16. at A, where the *Cheeks*, *Puppets* and *Rest*, &c. are much stronger, and the P*ikes* stronger and longer than those the common *Turners* use. Their *Edge Tools* which they call *Hooks*, are also of a different shape, as the Figures of them described at B 1, B 2, B 3. in the said *Plate* shew, as being bent backwards and forwards towards the cutting end, somewhat like an z. And as the common *Turners* work with a round *String* made of Gut, as hath been described *Numb.* 10. § 1. ¶ 14. The *Brasiers* work with a *Flat Leather Thong*, which wrapping close and tight about the *Rowler* of their *Mandrel* commands it the easier and more forcibly about. Their *Thong* runs between the *Cheeks* of the *Lathe*.

The whole *Lathe* and its parts are made so strong because the Matter they *Turn* being Mettal, is much heavier than Wood, and consequently with forcible coming about, would (if the *Lathe* were sleight) make it tremble, and so spoil the Work; as hath been said before.

The reason why the *Hook* is so turned backwards, and again forwards, towards the end, is, that they may the better direct the Edge of it as much below the Horizontal Plain of the P*ikes* as they list, the better (in many cases) to come at the Work: For contrary to Soft Wood, Hard Wood and Ivory *Turners*, they always dip the end of their *Hook* below the *Rest*, that

ſo the *Hook* reſting very ſteddy upon the *Reſt*, and alſo againſt one of the Iron *Pins* ſtanding upright in the *Reſt*, and held very ſteddy forwards to the Work, the ſtrong coming about of the Work againſt the ſtrong Edge of the *Hook*, ſcrapes off the extuberant Mettal lying in that Sweep.

I need no further deſcribe the *Lathe*, and other *Tools* that belong to *Braſiers* Turning; or more of the manner of uſing them; becauſe, by the whole preceding Diſcourſe theſe Arguments are largly and ſufficiently handled: eſpecially conſidering I have given you the Figures of them in *Plate* 16. as aforeſaid.

Only, their way of *Whetting* their *Tools* being different from the *Whetting* of other Turning *Tools*, I ſhall ſay ſomewhat to: For they *Whet* their *Hooks* upon a broad Flat Slate, holding the *Hook* almoſt perpendicular, that the *Baſil* of its Edge may comply with the Flat of the *Slate*; with claſping the upper end of the *Handle* in their left hand to lean the heavier on it, and clutching the *Shank* of the *Blade* near the *Hook*-end in the right hand, to guide it: And thus with Spittle or Water rub forwards and backwards on the Slate, till they have ſharpned the Edge of the *Hook*. But if it be a Round end *Hook* they whet, they chuſe a *Groove* in the *Slate* fit to comply with the round edge of the *Hook* (for they have different ſized Grooves in the Slate for that purpoſe) and ſo in it rub forwards and backwards as aforeſaid.

## § XVIII. *Of* Turning *Small Work, of* Braſs *or other* Mettal.

SMall Work in *Mettal* is *Turned* in an *Iron Lathe* called a *Turn-Bench*. The Figure of it is deſcribed in *Plate* 16 at C. When they uſe it they ſcrew it in the *Chaps* of a *Vice*, and having fitted their Work upon a ſmall *Iron Axis* with a *Drill-Barrel* fitted upon a ſquare Shank at the end of the *Axis* next the left hand, they with a *Drill-Bow* and *Drill-ſtring* carry it about, as was ſhewn *Numb.* 1. *fol.* 6, 7. with this difference, that when a Hole is drill'd in a piece of Mettal, they hold the *Drill-bow* in their Right Hand; but when they *Turn* Small Work, they hold the *Drill-bow* in their left hand, and with their right hand uſe the *Tool*, which is commonly a *Graver* or ſometimes a *Sculptor*, fit to ſuch Moldings as are to be made on the *Mettal*.

They begin to work firſt with the ſharp point of a *Graver*, laying the Blade of it firm upon the *Reſt*, and directing the point to the Work, and lay Circles upon it cloſe to one another, till they have wrought it pretty true: Then with one of the broad Edges of the *Graver* they ſmoothen down what the Point left, and afterwards with *Sculptors*, *Round* or *Flat*, or great or ſmall, they work their intended Moldings.

The Circumſtances and Conſiderations in the choice of a *Drill-bow* and *Drill-ſtring* for *Turning*, are the ſame with what you find *Numb.* 1. *fol.* 6, 7. for Drilling.

§ XIX.

## § XIX. *Of laying* Moldings *either upon* Mettal *or* Wood, *without fitting the Work in a* Lathe.

I Had ſoon after the Fire of *London* occaſion to lay Moldings upon the Verges of ſeveral round and weighty flat pieces of *Braſs*: And being at that time by reaſon of the ſaid Fire unaccommodated of a *Lathe* of my own, I intended to put them out to be *Turned:* But then *Turners* were all full of Employment, which made them ſo unreaſonable in their Prizes, that I was forc'd to contrive this following way to lay Moldings on their Verges.

I provided a ſtrong Iron *Bar* for the *Beam* of a *Sweep*: (for the whole *Tool* marked in *Plate* 16, is by Mathematical *Inſtrument-makers* called a *Sweep.*) To this *Tool* is filed a *Tooth* of Steel with ſuch *Roundings* and *Hollows* in the bottom of it as I intended to have *Hollows* and *Roundings* upon my Work : For an Hollow on the *Tooth*, makes a *Round* upon the Work ; and a *Round* upon the *Tooth* makes an *Hollow* on the Work ; even as they do in the *Molding Plains Joyners* uſe. Then I placed the *Center-point* of the *Sweep* in a Center-hole made in a ſquare *Stud* of *Mettal*, and fixed in the *Center* of the Plain of the Work: and removed the *Socket* that rides on the *Beam* of the *Sweep* till the *Tooth* ſtood juſt upon its intended place on the Verge of the Work, and there ſcrew'd the *Socket* faſt to the *Beam.*

To work it out, I employ'd a Labourer, directing him in his left Hand to hold the Head of the *Center-pin*, and with his Right Hand to draw about the *Beam* and *Tooth*, which (according to the ſtrength) he us'd, cut and tore away great Flakes of the *Mettal*, till

it

it receiv'd the whole and perfect Form the *Tooth* would make; which was as compleat a Molding as any Skilful *Turner* could have laid upon it.

Having ſuch good Succeſs upon *Braſs*, I improv'd the Invention ſo, as to make it ſerve for Wood alſo. And made a *Plain-Stock* with my intended Molding on the *Sole* of it, and fitted an *Iron* to that *Stock* with the ſame Molding the *Sole* had.

Through the ſides of this *Stock* I fitted an Iron *Beam* to do the Office of the *Beam* I uſed for the *Sweep*, *viz.* to keep the Plain always at what poſition I liſted from the Center (for thus the Iron in the Plain wrought about the Center, even as the Tooth in the *Sweep* (before rehearſed) and to that purpoſe I made a round Hole of about half an Inch Diameter near the end of the Iron: Then in the Center of the Work I fixed a round Iron *Pin*, exactly to fit the ſaid Round Hole, putting the Round *Hole* over the *Pin*, and fitting the *Iron* into the *Stock* commodious to work with. I uſed this Plain with both Hands, even as *Joyners* do other *Plains*: For the *Iron Pin* in the Hole of the *Beam* kept it to its due Diſtance from the Center; ſo that neither hand was ingaged to guide it.

But note, The *Stock* of this *Plain* was not ſtraight (as the Stocks of other Plains are) but by Hand cut Circular pretty near the ſize of the Diameter of the intended Molding: And yet was made to ſlide upon the *Beam*, farther from, or nearer to the Center, as different Diameters of Verges might require.

## § XX. *To Turn ſeveral* Globes *or* Balls *of* Ivory *within one another, with a* Solid Ball *in the middle.*

YOU muſt firſt Turn your *Ivory Ball* or *Globe* truly round, of your intended Diameter: Then deſcribe a Circle exactly through the middle or Equinoctial of the *Globe*: Divide that Circle into four equal parts, and pitch one point of a pair of Compaſſes in one of thoſe Deviſions, and extend the other point to either of the next Deviſions, and deſcribe with it a Circle round about the *Globe*. Then remove the ſtanding point of the Compaſſes to either of the next Deviſions in the Equinoctial, and in like manner deſcribe another Circle round about the *Globe*.

But note, that the moving Point of your Compaſſes muſt be ſomewhat bended inwards; For elſe its point will not deſcribe a Circle on the greateſt Extuberances of the *Globe*, but will ſlide off it.

Thus ſhall the Ball or Globe be divided into eight Spherical Quadrants: Deſcribe as great a Circle as you can in each of theſe Quadrants, and each two Centers of every two oppoſite Circles ſhall have an imaginary *Axis* paſs between them: And if the *Globe* be ſucceſſively pitcht upon all the reſt of the Centers, ſo as the imagined *Axis* paſſing between it and its oppoſite Center, lie in a ſtraight line with the *Pike* and the Center of the *Coller* it is *Turned* in, the working out of all the *Hollows* on the *Ball* will be but common *Turners* Work,as you will find hereafter. This is in brief the Theory :But to the Practice. You

You muſt uſe an *Hollow Mandrel*, made fit ſtifly to receive the convexity of the *Globe* in its concavity, ſo as it may ſtick firmly in the *Mandrel* in its Poſition: And you muſt take care that in pitching the *Globe* into the *Mandrel*, that the imaginary *Axis* of the *Globe* (which is the Line paſſing between the two Centers of the two oppoſite Circles as aferoſaid) lie in a ſtraight Line with the *Axis* of the *Mandrel*; which you may know by examining whether the Circle deſcribed with your *Compaſſes* (as aforeſaid) on the Center (aforeſaid) wabble not in a whole Revolution of the *Globe* from the point of a Tool applyed ſteddy to it.

Having thus pitcht the *Globe* true, and fixt it faſt into the *Mandrel*, you muſt begin to work with the *Triangular Grooving Point* (deſcribed *Numb.* 11. § 5. and *Plate* 15.) placing the point of it pretty near the Center of the Circle, and work into the *Ball* with the *Grooving Point*, and ſo by degrees make a Hollow in the *Ball* ſo deep and ſo wide as you think convenient, I mean ſo deep from the Superficies of the *Globe* towards the Center of the *Globe*, and ſo wide from the Center of the Circle deſcribed on the Superficies of the *Globe* towards that Circle, as it may have a convenient Subſtance between this Hole and the next intended to be *Turned*.

Thus muſt every one of the eight Circles deſcribed on the *Globe* be ſucceſſively by the ſame Rule, and after the ſame manner be pitcht outwards, and fixt into the *Mandrel*, and then Hollowed out as the firſt was. Where note, that every Hollow is to be *Turned* to the ſame depth and

width exactly as the first was: Which to do, you must use a *Gage* made of a thin Plate of Iron or Brass, as is described in *Plate* 17. *Fig.* D. whose two sides from *a* the Bottom of the *Gage*, to *b* the *Shoulder* are the depth of the *Hollow* from the Superficies of the *Globe* towards the Center: *b b.* is the width of the *Hollow* at the Superficies of the *Globe*; and *a a* is the bottom width of the *Hollow*; and the concave Arch between *a a* is an Arch that the Convexity of the little Solid *Ball* to be *Turned* within all the *Spheres* must comply with. So that when each *Hollow* is *Turned*, the *Gage* must be put into it to try how the sides of the *Hollow* complies with the sides of the *Gage*, and also how the Arch in the bottom of the *Gage* complies with the surface of the Solid *Ball* in the middle.

Having thus *Turned* all the *Hollows* in the *Globe*, you must provide several thin and narrow Arching *Grooving Tools*, whose convex and concave Arches comply both with the Convexity and Concavity of each *Globe* or *Sphere* to be *Turned* within the outermost: So that beginning at the Bottom of the Hollow, you Turn just half way of the Solid *Ball* loose from the Sphere it is contanied in, *viz.* as far as the Equinoctial of the *Globe*; and in thus Turning it, you must take great care, that the Solid Ball on its Convexity and the Concavity of the Sphere it is contained in, be both at the same time Turned exactly Spherical.

Thus one half of the Solid *Ball* being *Turned* loose, you may in like manner *Turn* the next Sphere it is included in half loose also: And so successively as many Spheres as you list.

Having

Having thus *Turned* one half of all the *Spheres* looſe, you muſt take the whole *Globe* out of the *Hollow Mandrel*, and pitch and fix the *Globe* again into the *Mandrel*, ſo as the imagined *Axis* of the *Hollow* oppoſite to the laſt looſned Hollow lie in a ſtraight line (as before was taught) with the *Pike* and *Center* of the *Coller* the *Mandrel* runs in, and then *Turn* the other half of the Solid *Ball* and *Spheres* alſo looſe, as the firſt half was *Turned*.

## § XXI. *To* Turn *a* Globe *with ſeveral looſe* Spheres *in it, and a* Solid Cube *or* Dy *in the middle of it.*

THis is *Turned* after the ſame manner the former *Ball* was *Turned*; only inſtead of dividing the Equinoctial of that *Globe* into four equal parts, the Equinoctial of this muſt be divided but into three Equal parts, and their Semi-Circle drawn through the diviſions into either Pole of the *Globe*: So ſhall the *Globe* be divided into ſix equal parts or Segments; in each of which parts muſt be deſcribed a Circle, as was deſcribed before in the *Globes* of eight equal parts; and in theſe ſix Circles muſt be made ſix Hollows, as before there was eight: But inſtead of working the Bottom of each Hollow Spherical, now the Bottom muſt be wrought Flat: So ſhall the *Cube* when theſe ſix Hollows are thus made, be formed: and the Hollows being exactly of the ſame depth, and flat in the Bottom, the *Cube* or *Dy* will looſen, and each of the ſix Flats in the Bottom will become the ſix ſides or Faces of the *Cube*.

The manner of loosning all the other inward *Spheres* is as the Former: Only, that was loosned with twice pitching the B*all* in the *Mandrel*, because the Centers of the *Hollows* lay opposite to one another; But to loosen this B*all* will require three Pitchings into the *Mandrel*; because the Centers lie not opposite to one another.

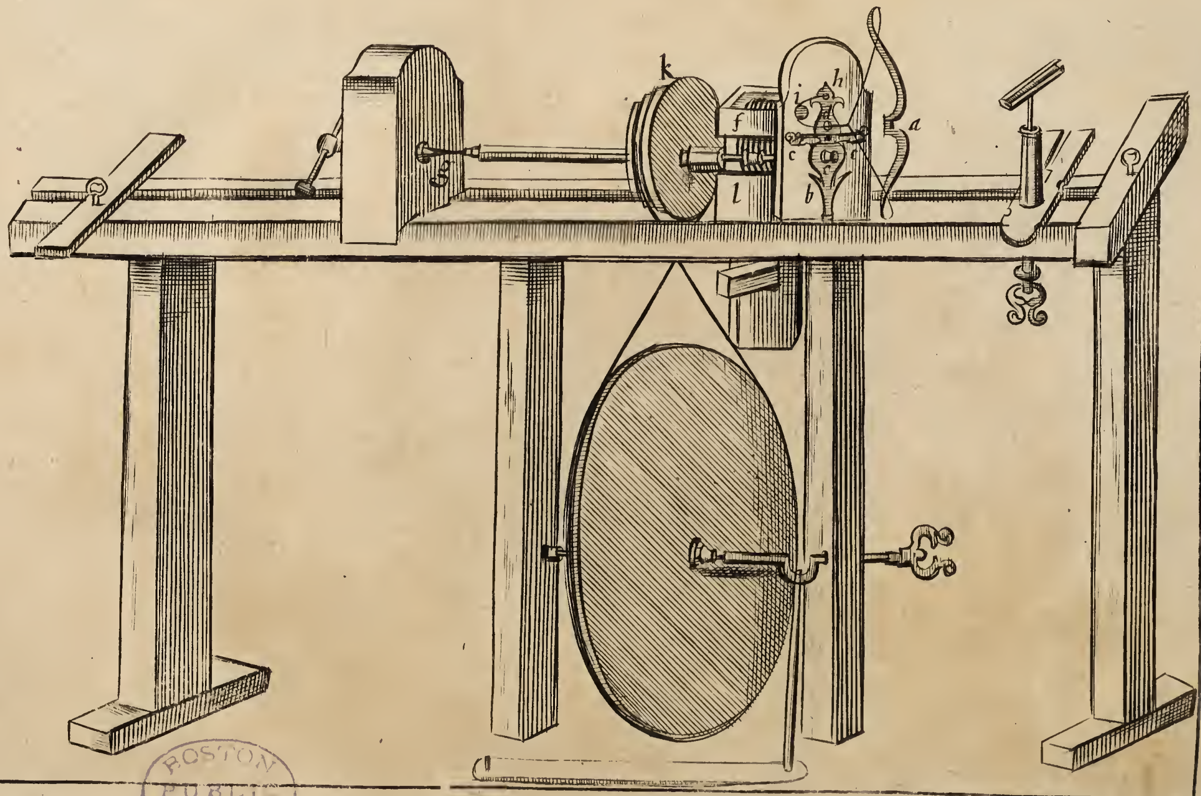
### § XXII. *To* Turn *a* Cube *or* Dy *in an Hollow* Globe, *that shall have but one Hole on the outside to work at.*

THE Outside of this *Globe* must be Turned Round, *viz.* Spherical, as the former, and fixed in an Hollow *Socket* (as before hath been taught) Then must an Hole be Turned in the *Globe* so deep and so wide as you please, as in the Former *Globes*, and the Bottom of that Hole Turned Flat, for one side or Face of the *Cube* or *Dy*: Then with a Semi-circular Tool loosen the whole Core or middle of the Ball, and pitch the Core with the point opposite to the Center of the already Flatted Face of the *Dy* outwards against the Hole in the *Globe*, and so fasten it in this position, by powring in some melted Hard Wax or other Cement; and then with a Flat Tool Turn the Foreside (*viz.* the side opposite to the first side) flat also: Which done, loosen it out of the Wax, and successively pitch the other sides to be Turned Flat carefully against the Hole, so as all the sides have Right Angles to each other, and fastning them with Wax or Cement (as before) Turn them by the same Rule flat also.

Now

Now to make this Thing more admirable to the ignorant Spectator, you may make the *Dy* as big as you can, and the Hole you Turn it at as little as you can; that it may the more puzzle the Wit of the Enquirer to find how ſo great a *Dy* ſhould have Entrance at a ſmall Hole, unleſs the Hollow Ball were Turned in two Halves, *&c.*

*Plate 17.*



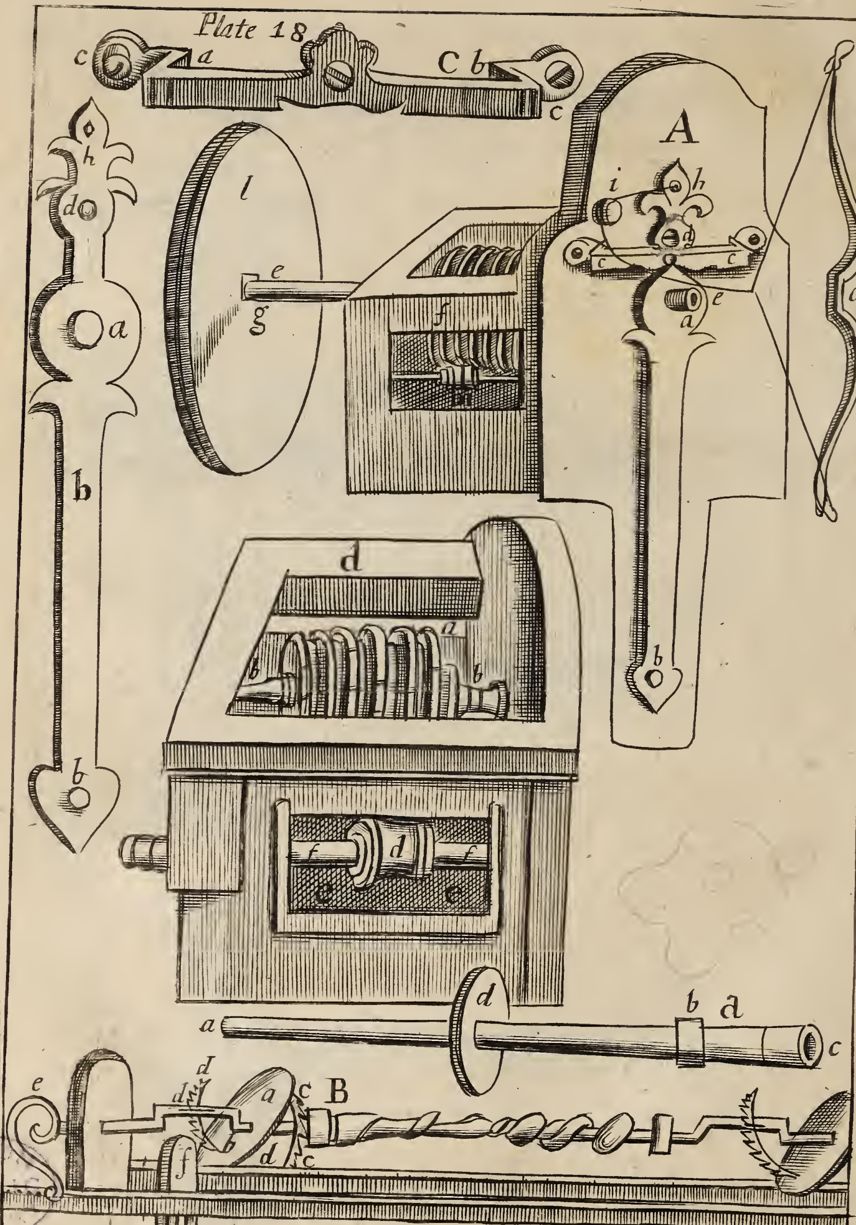


Plate 18
A
B
C

*Numb.* XIV.

# MECHANICK EXERCISES,

J J Greenough

OR

The Doctrine of

# Handy-Works.

Applied to the Art of *TURNING.*

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By *Joſeph Moxon*, Member of the *Royal Society*, and *Hydrographer* to the Kings moſt Excellent Majeſty.

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# MECHANICK EXERCISES,

Property of OR, J. J. Greenough

## The Doctrine of

# Handy-works,

## Applied to the Art of TURNING.

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### § XXIII. *Of Turning* Oval Work.

THis Work may be perform'd in the Common *Lathe* that goes either with the *Treddle* Wheel or the great Wheel; because the Work must run always one way, if the *Puppet* be made to it with the Machination described in *Plate* 17. and an Iron *Axis* be made to carry the Work about, and to its end be fitted and fastned a *Brass Collar* with a Female Screw in it, to screw on the *Mandrel* that the Work you intend to Turn is fixt upon.

To the Foreside of this *Puppet* is fastned at *b* as on a Center-pin a strong Iron *Collar* marked *b h*, and this Collar is called the *Moving-Collar*; because it moves between the Iron *Shackle c c* and the Fore side of the *Puppet*. Into this *Moving Collar* is fitted the *Hollow Axis* marked *c*, so as to turn round in it as if it were in any of the other *Collars* formerly described; but the *Moving Collar* moving between the

*Shackles* and the Fore-ſide of the *Puppet* carries the *Hollow Axis* with it athwart the *Puppet*, even ſo far as is the width of the *Hollow* between the *Shackle* and the Fore-ſide of the *Puppet*. And thus by the moving of the *Hollow Axis* backwards and forwards the Work ſcrewed in it, having an *Edg'd* or a *Pointed Tool* applied to it receives that *Oval* Form which is made upon the *Guide*.

But to make it move thus to and from you, there are required ſeveral Machinal Helps: For there is a ſtrong *Steel Bow* as at *a* faſtned about its middle part to the further ſide of the *Puppet*, which ſtands about an Inch forwarder than the Fore ſide of the *Puppet* with its hollow ſide to the Workman. And to the ends of this *Steel Bow* is faſtned a ſtrong *String* of Gut, and to the middle of that *String* in a Noos is faſtned another ſtrong *Gut-ſtring* with a Noos at its end. This laſt mentioned *String* is made exactly of that length that when the neareſt ſide of the *Guide*, *viz.* its leaſt Diameter is ſet into the *Groove* of the *Guide-pulley*, and the *Bow* is ſtrained, and this *String* laid in the *Groove* of the *String-pulley*, the Noos at the end of it may be put over the Iron *Button* fixed in the top of the *Moving-Collar*. For then as the *Treddle-Wheel* carries the *Axis* about, the *Guide* being firmly faſtned upon the *Axis* comes alſo about; and having the *Groove* of the *Guide-pulley* ſet againſt the outer edge of the *Guide*, as the great Diameter of the *Guide* is turned againſt the *Guide-pulley*, the *Moving-Collar* being drawn by the ſtrength of the *Bow*, draws the *Hollow Axis* along with it, as alſo the Work ſcrewed in the *Hollow Axis*: And thus as the ſmall Diameter of the *Guide* comes to the *Guide-pulley*, the ſmall Diameter of the Work is Formed; and as the great

Diame-

Diameter of the *Guide* comes to the *Guide-pulley*, the great Diameter of the Work is formed.

This is the Sum of *Oval Turning.*

But that the whole Machine may be yet better underſtood, I ſhall more particularly give you the names of all its parts, together with a Deſcription upon its moſt material parts, where the *Fore-Puppet* is more largely delineated in P*late* 18 at A, where alſo ſome of the Members moſt difficult to be deſcribed are drawn more at large by themſelves.

*a* The *Bow.*
*b* The *Moving Collar.*
*c c* The *Socket* in which the *Collar* is moved.
*d* The *Stop-ſcrew*, to take out when the *Hollow Axis* moves in the *Moving Collar.*
*e* The *Hollow Axis.*
*f* The *Head*, in which is contained the ſeveral *Guides:*
*g* The *Center Head*
*h* The *Button.*
*i* The *String-pulley.*
*k* The *Wheel-pulley.*
*l* The *Guide-pulley.*

¶ 1. *Of the* Hollow Axis *and its* Shank, *marked* a *in* Plate 18.

THE *Shank* is a Bar of Iron about an Inch thick, and two Foot long, having in its further end a Center-hole to pitch upon the P*ike* in the further *Puppet*; but its hither end is made ſquare to fit tight into a ſquare *Socket* in the Braſs *Hollow Axis*: And when it is thus fitted into the hither end of the

Braſs, it is Turned true Cilindrically round, ſo as to fit into the round Hole in the *Moving Collar.* The Diameter of the Round is about two Inches, and the length about two Inches ſtraight; but then a Shoulder is Turned to the Braſs Cilinder, to ſtop it from ſlipping through the *Moving Center.* In the Fore-end of this *Hollow-Axis* (*viz.* in the Braſs Cilinder) is Turned a wide Hole about an Inch and a quarter Diameter, and an Inch deep: And in this wide Hole is Turned a Female Screw with a courſe Thred, to receive a Male Screw made behind the *Mandrel* that the Work is fixed upon.

About the middle of this Iron *Shank* is placed a *Pulley* made of Wainſcot Board, about eight Inches Diameter, and an Inch thick, with a *Groove* on its outer edge about half an Inch wide, and half an Inch deep for the *String* of the *Treddle Wheel* that carries the *Axis* about to run in: And between this *Pulley* you may (if you will) have ſeveral lengths of ſuch *Male-ſcrews* as was deſcribed *Numb.* 11. § 6. ¶ 4. and *Plate* 15. to make Screws with, if you pleaſe.

See the Figure *a d c b*, disjunct from the reſt of the Work.

*a* The hinder end.

*d* The Pulley of the *Axis*, or *Wheel-pulley.*

*c* The Hollow or Hole in the Fore-end of the *Hollow Axis.*

*b* The *Shoulder* of the *Hollow Axis.*

### ¶ 2. *Of the* Moving Collar marked b in *Plate* 18.

THis whole Member is called the *Moving Collar,* though the *Collar* ſtrictly is only the round Hole at *a*, into which the *Hollow Axis* is fitted. It is made of

of Iron to reach from its top at *h* (the *Button*) down to the bottom of the *Cheeks* of the *Latke*, as at *b*; upon which Pin (as on a Center) the whole *Moving Collar* moves backwards and forwards; its extream Breadth is about three Inches, and its thickneſs above a quarter of an Inch. Its Neck at *c* is claſped but not fixed down to the Fore-ſide of the *Puppet*; for this *Neck* is only gaged in the *Shackle* marked *c*, ſo as the *Neck* (and conſequently the whole *Moving Collar*) may ſlide from end to end of the *Shackle* forwards and backwards. *d* A ſmall *Female Screw*, into which through a Hole in the *Shackle* is fitted a Male *Screw* to hold the *Moving Coller* and the *Shackle* together, that the *Moving Collar* may not move when only round Work is Turned in the *Collar*.

¶ 3. *Of the Fore-ſide of the* Puppet, *and the* Shackle *marked* c.

UNder this *Shackle* (*viz.* between it and the Fore-ſide of the *Puppet*) moves the *Neck* of the *Sliding Collar* from *a* to *b*, when the ends at *c c* are fixed down to the Fore-ſide of the *Puppet* with two Iron Screws.

¶ 4. *Of the* Hollow *in the* Puppet *marked* d.

IN the middle of the *Puppet* is hollowed out a Hole about three Inches between the Fore and Backſide of the *Puppet*, and four Inches athwart the *Cheeks* in the *Puppet*, and four Inches deep: So that about an Inch of Subſtance remains on each of the four upright ſides. But the Top is quite open. (as at *a*) Through the middle of this ſquare *Hole* runs the Iron *Axis*

 marked

marked *b b*, on which is fixed the ſeveral *Guides* that are to be uſed in this ſort of Working.

It is open at the Top, that Light may be let in to ſet the *Guide-pulley* to which *Guide* you pleaſe, and it is open on the hither ſide as at *e e* about an Inch and an half above and below the *Axis*, that the *Guide-pulley* may be ſlid on its *Axis* to any of the *Guides*.

The *Guide-pulley* marked *d* is a Braſs Pulley of about an Inch Diameter, and a little above a quarter of an Inch thick, having a *Groove* in the Edge of it to receive the Edge of the *Guide*. It hath in its middle a round Hole about half an Inch Diameter, which round Hole ſlips over a round Iron P*in* of the ſame Diameter, marked *f f*, ſo as it may ſlide from one end of the ſaid Iron P*in* to the other, according as the *Guides* may be fixed towards either end.

When it is uſed, the Groove in the Edge of this *Guide-pulley* is ſet againſt the Edge of the *Guide*, and being fitted tight on the round Iron P*in* aforeſaid, and the two ends of the Iron Pin faſt fixed into the Wood of the P*uppet*, the *Guide-pulley* may indeed move round on the Iron P*in*; but the ſtrength of the Iron P*in*, and *Guide-pulley* will reſiſt the extuberick parts of the Edge of the *Guide*; and ſo with the aſſiſtance of the ſtrength of the *Steel Bow* force the *Guide* and *Hollow Axis* to move backwards; and then an Edge-Tool held to the Work in the *Mandrel* ſcrewed in the *Hollow Axis* will deſcribe the ſame Figure on the Work as is on the outer Edge of the *Guide*.

Note, that when you are at Work, you muſt keep the Hole in the middle of the *Guide-pulley* well oyl'd,

as

as alſo the round Iron P*in* it ſlides and turns round upon; becauſe this *Guide-pulley* ought to run round: For then the *Axis* will have an eaſier and ſwifter motion, though it may indeed perform the Work if it run not round upon the Iron Pin.

### § XXIV. *Of* Roſe-Work, *&c.*

ROſe-Work Turning, or Works of any other Figure, are performed by the ſame Rule and after the ſame manner as *Oval Work* is made; only by changing the *Guides*, and uſing one whoſe outer Edge is made with the Figure, or ſeveral Figures you intend to have on your Work.

### § XXV. *Of Turning* Swaſh-Work.

TO the Turning of *Swaſh-Work* you muſt have two ſuch P*uppets* as the *Fore-puppet* deſcribed in § 22. And alſo a Round *Swaſh-board*, about ten Inches Diameter, and an Inch and an half thick, as is *a* in Fig. B. *Plate* 18. Upon both the Flat ſides of this *Swaſh Board* in a Diametrical Line is faſtned upright an Arch of a Quadrant made of a Steel Plate, about half a quarter of an Inch thick, and an Inch and a quarter broad, as at *b b*, *c c*. The convex edges of theſe Quadrants are cut into Notches, like the Teeth of an Hand-Saw; that according as you may have occaſion to ſet the *Swaſh-Board* more or leſs aſlope, you may be accommodated with a Notch or Tooth to ſet it at. This *Swaſh-Board* hath an Hole made about its Center, to ſlip over the *Iron Axis*: And being thus ſlipt over the *Iron Axis*, you ſet it to that Slope you intend the *Swaſh* on your Work ſhall

ſhall have. And to fix it faſt in this poſition, you muſt put the Blades of the Quadrants into two *Slits* made in the *Iron Axis* as at *d d*, and fit the two oppoſite Teeth againſt the two outer Shoulders of the *Slits*.

You muſt moreover make two ſtrong Steel *Springs* as at *c c*, to reach from the bottom of the outer ſides of the *Puppets*, being ſtrong nailed, or rather ſcrewed down there, which muſt reach up ſo high as the *Axis*. And in the inner ſides of theſe *Springs* muſt be made two Center holes for the points of the *Axis* to be fitted in: For the *Oval-Guide* being fitted to one end of the *Axis*, and a Low-Puppet, as at *f*, wedged cloſe to one ſide of the *Swaſh-Board*, when the *Swaſh-Board* ſtands in its greateſt declirity; Then in a Revolution of the *Axis*, as the farther part of the Circumference of the *Swaſh-board* comes to the *Low-Puppet*, one *Spring* will be forced backwards, and the other will ſpring forwards; and an Edg'd-Tool held againſt the Work fixed on the *Axis*, will make on the Work the Form of a *Swaſh*, &c.

Theſe *Oval-Engines*, *Swaſh-Engines*, and all other *Engines*, are excellently well made by Mr. *Thomas Oldfield*, at the ſign of the *Flower-de-luce*, near the *Savoy* in the *Strand*, *London*.

Thus much of *Turning*: My next *Exerciſes* will (God willing) be upon the Art of *Printing*.

# *An Explanation of* Terms *used in these Exercises of* Turning, *Alphabetically digested.*

## A.

AXIS. The imagined straight Line that passes through the two Center-points that Turned Work is Turned upon. Thus the imagined Line that passes between the two Pikes through the Work in the Lathe is the Axis.

## B.

BOW. The Bow that Common Turners use is described Numb. 10. § 1. ¶ 11. And the Bow that Oval Turners use is described Numb. 14. § 23. and Plate 17, 18. at *a*.

*Button*. The Button is described Numb. 14. § 23. and Plate 17. at *h*.

## C.

CAllippers. Compasses with bowed shanks to measure the Diameter of any round Body. See Numb. 12. § 11. and Plate 14. at O.

*Center-Head*. See Numb. 14. § 23. and Plate 17. at *g*.

*Cheeks*. See Numb. 10. § 1. ¶ 2. and Plate 12. *b b*.

*Chock*. See Numb. 11. § 6. ¶ 5. and Plate 13. at F 5. *a*.

*Cleaving-knife.* See Numb. 12. § 9. and Plate 13. at M.

*Crank.* The end of an Iron Axis turned Square down, and again turned Square to the first turning down, so that on the last turning down a Leather Thong is slip't, to Tread the Treddle-wheel about.

*Collar.* See Numb. 11. § 7. and Plate 13. at G H I.

*Crook.* See *Crank.*

*Cross-Treddle.* See Numb. 10. § 1. ¶ 8. and Plate 12. at *k.*

## D.

D*Rill-Barrel.* See Numb. 1. Fol. 6. Plate 1. and Fig. 8. at C.

*Drill-Bench.* See Numb. 12. § 12. Plate 14. at *a a a a.*

*Drill-Bow.* See Numb. 1. Fol. 6, 7.

## F.

F*Emale Screw.* The Screw made in the round Hole of a Nut.

*Flat-Chissel.* See Numb. 11. § 3. and Plate 15. at C C.

*Flat-Mandrel.* See Numb. 11. § 6. and Plate 13. at F 1.

## G.

G*Ouge.* See Numb. 10. § 2. ¶ 1. and Plate 15. at B B.

*Great Wheel.* See Numb. 10. § 1. ¶ 12. and Plate 14. at a.

*Grooving Hooks.* See Numb. 11. § 5. and *Plate* 15. at E.

*Grooving Tools.* See *Grooving Hooks.*

Guide

*Guide*. See Numb. 14. § 23. ¶ 4. and *Plate* 18.
*Guide-Pulley*. See Numb. 14. § 23. ¶ 4. and *Plate* 18. at *d*.

## H.

HEad. See Numb. 14. § 23. and *Plate* 17. at *f*.
*Hook*. See Numb. 13. § 17. and *Plate* 16. at B 1. B 2. B 3.
*Hollow Axis*. See Numb. 17. § 17. and *Plate* 17. at *e*.
*Hollow Mandrel*. See Numb. 11. § 6. ¶ 3. and *Plate* 13. at F 3.

## I.

JOynt Collar. See Numb. 11. § 7. and *Plate* 13. at G.

## L.

LAthe. See Numb. 10. § 1. and *Plate* 12.
*Legs*. See Numb. 10. § 1. and *Plate* 12. at *aaaa*.

## M.

MAndrel. See Numb. 11. § 6. ¶ 1. and *Plate* 13. at F 1. F 2. F 3. F 4.
*Mawl*. See Numb. 12. § 8. and *Plate* 13. at K.
*Male-Screw*. The Screw made upon a Shank or Pin.
*Moving Collar*. See Numb. 14. § 23. ¶ 2. and *Plate* 18. at *b*.

## N.

NUT. A piece of Iron that a Female Screw is made in.

## P.



## R.



## S.



*Sweep.*

*Sweep.* See Numb. 13. § 19. and *Plate* 16. at D.

## T.

TRead. See Numb. 12. § 13. Fol. 209.
*Treddle.* See Numb. 10. § 1. and *Plate* 12. at *i.*
*Treddle-Wheel.* See Numb. 10. § 1, ¶. 13.
*Turn-Bench.* See Numb. 13. § 18. and *Plate* 16. at C.

## W.

WAbble. When a piece of Work is not pitcht true upon its Centers, it will in a Revolution incline more on one ſide of its Circumference than on its oppoſite ſide. See Numb. 14. § 23. and *Plate* 17. at *k.*

There are ſeveral other Terms uſed in theſe *Exercises* of *Turning* not explain'd here: But becauſe they are uſed in ſome of the former *Exerciſes*, and there explain'd, I ſhall refer you to them.

*The End of the Firſt Volume.*

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## ERRATA.

FOl. 185. at ¶ 10. for Side-Reſt r. Side-Pole. f. 186. l. 13. for Ruler r. Rowler. f. 191. l. 18. for Corner r. Convex. fol. 197, 198, 199, 200. throughout theſe Pages, for Plate 15. r. Plate 13. f. 126. l. 14. for marked in Plate. r. marked D. in Plate.